PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

MAY 1957

UNIVERSITY OF MICHIGAN
MAY 28 1957
ENGINEERING

PLASTER MOLD FOR FAN-HEATER

PROTOTYPE MODEL FABRICATED

FROM AN ORIGINAL PLASTER MODEL

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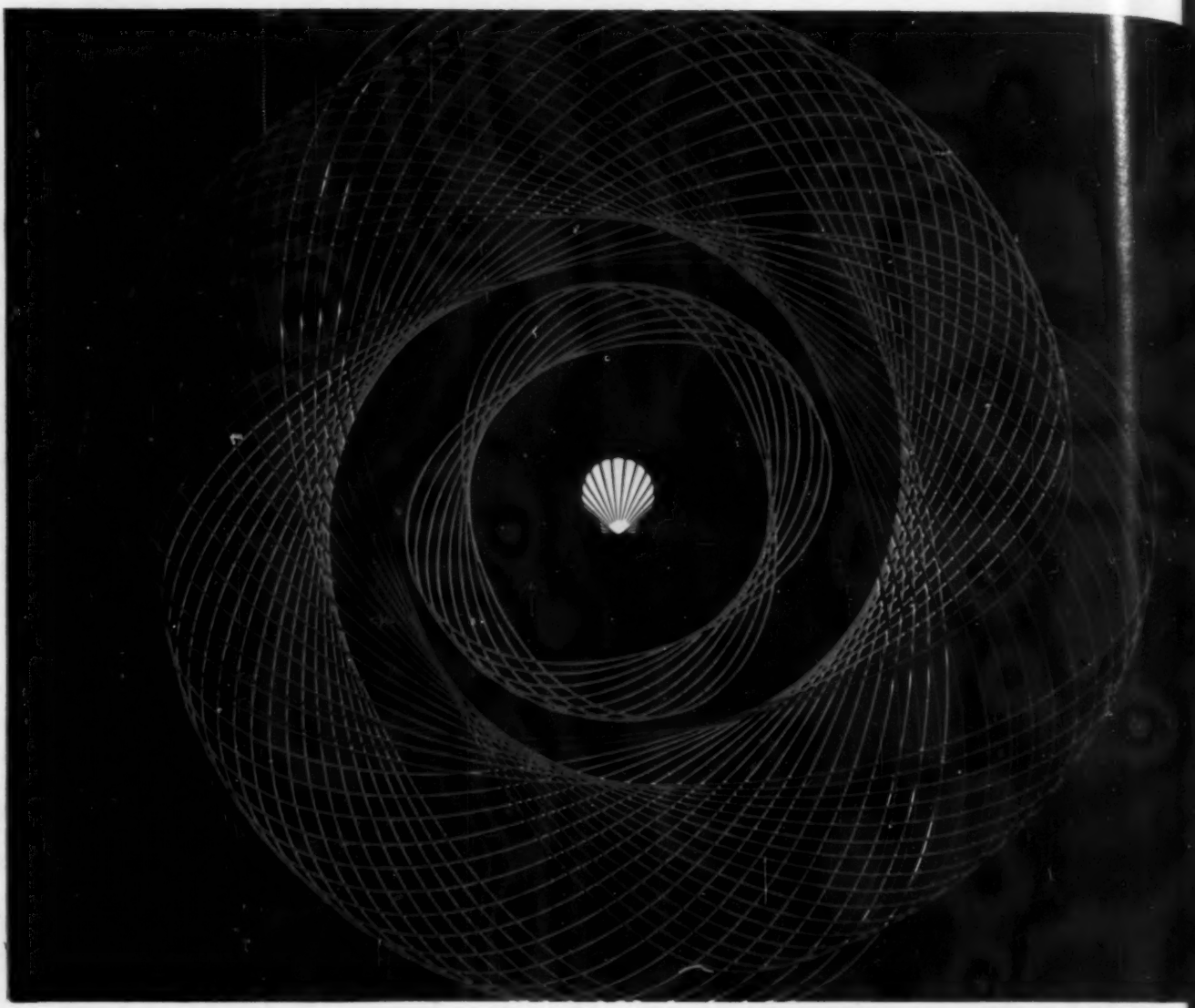

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PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

MAY 1957 VOLUME III, NUMBER 5

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Cover photo courtesy: General Electric Company

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Letters to the Editor

Article

Highlights

Importance of Mold Rigidity in Injection Molding. (p. 371).

Injection mold rigidity is discussed in relation to the molding of large-area parts with close dimensional tolerances and thin walls. Influencing factors include the alignment of mold cores and cavities, warpage and changes in mold dimensions, and deformation of mold pillars and back-up plates.

•

How to Predict Extruder Performance with Polyethylene. (p. 385)

The delivery characteristics of an extruder at a specified polyethylene temperature are defined, without reference to heating technique, screw-design variables, or operating conditions. The performance of existing extruder equipment can be predicted, as well as the design of screws and dies for specific applications.

•

Plastics in New Product Design. (p. 376)

Actual or simulated appearance models of new product designs can be made from currently-available plastic mold and casting materials, and improved finishing techniques. Plastic materials and techniques play an important role in providing the product designer with better appearance and engineering prototype models of new product designs.

•

Previews

The following articles will be published in the June issue:

Pressure Control for Injection Molding Machines. C. E. Beyer, group leader, Saran Polymerization Laboratory, Dow Chemical Co., Midland, Mich.

Extrusion of Nylon 6. R. L. Hughes, senior staff member, plastics laboratory, Spencer Chemical Co., Kansas City, Mo.

Sawing and Machining Glass-Reinforced Plastics with Diamond-Coated Tools. L. H. Barron, president, Dia-Chrome Co., Glendale, Calif.

Pyrotex Asbestos-Reinforced Plastics. D. V. Rosato, chief engineer, Reinforced Plastics Dept., Raybestos-Manhattan, Inc., Manheim, Pa.

The June guest editorial will be **"Scientific Manpower Problems"** by Frank Pray, president, Technicraft Co., Boston, Mass.

Corrects Telephone Cable Story

Dear Sir:

We have seen a short article in your February issue, page 124, on the trans-Atlantic telephone cable. Without wishing to criticize in any way the factual content of the article, we feel that a reader might be left with the impression that Bakelite polyethylene was used extensively in the cable as a whole. We would like to point out, however, that the main part of the cable, namely the two deep-water sections running from Newfoundland to Scotland, was insulated with Alkathene, the polyethylene manufactured by Imperial Chemical Industries, Ltd.

J. S. A. Forsyth,
Imperial Chemical Industries (New York), Ltd.
New York, New York

(Our abject apologies—if our readers got the impression that the entire cable was insulated with Bakelite polyethylene, we must confess that we were misled, too. Without saying so, the press release upon which our story was based also led us to think that only Bakelite polyethylene was used. Even editors are prone to the common tendency occasionally to skip over an important point when reading something.—Editor)

Wants Information on Fire Hazards

Dear Sir:

May I make a suggestion with respect to the Guest Editorial, "How to Avoid Plastics Misapplications," by Paul Fina, on page 115 of your February issue?

I am heartily behind Mr. Fina's thinking and feel that a handbook, as recommended, would have a definite place in the industry.

May I suggest, however, that an additional section be provided to point out the hazards to personnel, the public, and to property from the standpoint of fire in the end-use of a particular product.

Today, the common usage of synthetics is such that the convenience of the material in forming or substitution outweighs the hazard which might result from fire. I am certain the prompt publication of such properties would help to reduce the present apathy so many people have towards fire.

J. H. Jebens, Fire Protection Engineer,
Babylon, L. I., N. Y.

Questions "Materials Selection" Article

Dear Sir:

In perusing the article, "Functional Selection of Materials—Part I," in the February issue, we have noted pieces of misinformation. We feel that with the state of the plastics industry as it is today, the publication of incorrect data should be scrupulously avoided, especially in a publication such as yours. Since such data is commonly available in military specifications and other published literature, this negligence is unpardonable.

Specifically, the following is the correct data:

	Tensile Strength, Psi.	Compressive Strength, Psi.	Flexural Strength, Psi.
Silicone-glass	10-25,000	35-40,000	10-44,000
Polyester-glass	40-50,000	30-60,000	50-63,000

L. R. Sparrow and N. E. Talbert
Flushing, N. Y., Massapequa, N. Y.

The author's reply:

Readers Sparrow and Talbert are apparently confusing the properties of laminates with those of molding compounds. The basic mechanical properties of the polyester- and silicone-glass fiber molding compounds possess values closely approximating those tabulated in the article.

Perhaps some substantiating figures from additional authoritative sources will be helpful to them in their misapprehension.

I suggest they refer to the following:

	Tensile	Compressive	Flexural	Source
Silicone-glass	3-6,000 4-5,000	8-11,000 9-15,000	7-10,000 9-14,000	1 2
Polyester-glass	5-10,000 3,000 av.	15-26,000 Not listed	10-30,000 12,500 av.	3 4

Sources
1 Recognized technical data book.
2 Well-known properties chart, 1956 edition.
3 Authoritative book on Fiberglas-reinforced plastics.
4 Specifications of one of the leading manufacturers.

D. A. Dearle, Plastics Div. Mgr.,
North & Judd Mfg. Co.,
New Britain, Conn.

"Quote . . . Unquote"

Plastics as "Busy Bees"

"Of all the bees in the 'hives' of industry, the plastic people, since the end of World War II, have undoubtedly been the busiest. When you speak of an industry which encompasses everything from laying a plastic pipe line in Texas to providing the material for a San Francisco church mural, not to mention the revolution that plastics have brought about in our day-to-day lives, it is small wonder that those of us who are not in your field are apt to compare you with the busiest of all of nature's Creatures, (the bee).

"There is another reason for comparing your activities with those of the bee. Of all the wonders of nature that science has ferreted out, there is still one great mystery which our finest minds have never been able to unravel. This is: how does the bee make honey? The world of humanity is no nearer the answer to this than it was in the times of Solomon.

"To those of us who are not directly connected with the plastics industry, your work as Nature's own private secretary holds some of the same mystery. Although we all live and work and eat and travel surrounded by the material wonders which you have brought about, still we have little conception of the enormity of the jobs you have undertaken or the many facets of your research, experiment and development . . . The position you have attained . . . is an inspiration to the rest of us who have also been pioneering new fields."

Robert Prescott, President
The Flying Tiger Lines
Los Angeles, Calif.

• • •

Plastics Industry Growth

"The plastics industry today has one of the fastest growth rates extant, as evidenced by the myriad of new plastic products appearing on the market from day to day. Among the new items, the chemical industry believes there is a big opportunity for expanded use of plastics as another class of engineering material in the building industry.

"In cooperation with the fabricators and regulatory officials, we have recommended changes in existing building codes to allow for equitable and reasonable use of plastics in accordance with suitable performance and safety standards. The magnitude of the building industry, . . . estimated at $46-billion per yard, certainly indicates that possibilities for new and economical construction materials are almost unlimited."

M. F. Crass, Jr., Secretary,
Manufacturing Chemists' Association, Inc.,
Washington, D. C.

A NEW PHENOLIC, SEMI-IMPACT MOLDING COMPOUND WITH IMPROVED WATER RESISTANCE AND DIMENSIONAL STABILITY
PLENCO 476
When exposed to water, steam, detergents and rust inhibitor environments, molded plastic parts can absorb as much as 6 to 8% weight. This causes dimensional changes of from 1.5% to 2.2%, and results in cracking or warping of parts.
Plenco's new formulation, 476, has greatly improved water resistance. After 120 hours of continuous boiling in a 3% commercial detergent water solution, Plenco 476 has a total moisture gain of less than 2%. Dimensional change less than 0.5%. An additional 240 hours of continuous exposure to boiling produced no further gain in weight or dimensional change.
SPECIFIC GRAVITY
1.38-1.40
IMPACT STRENGTH
0.35-0.39 ft. lbs. per inch of notch
TENSILE STRENGTH
6500-7500 psi.
WATER ABSORPTION GAIN
0.3-0.4% (ASTM)
DIELECTRIC STRENGTH
(S/T) 250-300 volts per mill
POWER FACTOR
0.04-0.06 at 1000 KC.
HEAT RESISTANCE
Excellent to 325°F. over long exposure
PLASTICITY
Soft to hard
PERFORMABILITY
Can be tableted with automatic equipment
Applications of Plenco 476 include such items as water pump impellers, blowers, vaporizers, humidifiers, agitators, dishwasher and washing machine components, etc.
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In addition to their present importance as solvents for compounding and finishing plastics, the Nitroparaffins are a source of many polyfunctional molecules of interest in the manufacture and improvement of plastics.

Trained technical representatives may be reached at any CSC sales office for work on your specific product or processing problems. Or, write for specific application information, technical data sheets and samples.

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VINYL RESINS AND COPOLYMERS: *Nitroparaffins* — Are good solvents for polyvinyl acetate and many of the vinyl chloride-acetate polymers. They have the advantage over the ketones of allowing higher solids content at no increase in cost. Also, there is less solvent retention in the film where Nitroparaffins are utilized and much less of an odor problem. *Nitromethane* in the presence of toluene is the most powerful solvent of the group.

EPOXY RESINS: *1-Nitropropane and 2-Nitropropane*—Are outstanding solvents for epoxy resins, giving high solids, low viscosity and greatly improved flow characteristics at no extra cost.

UREA-FORMALDEHYDE RESINS: *2-Amino-2-methyl-1-propanol (AMP)*— Used as a stabilizer for urea or melamine formaldehyde finishes.

2-Amino-2-methyl-1, 3-propanediol (AMPD) — Used as a catalyst for making urea-formaldehyde resins.

ALKYD RESINS: *2-Amino-2-methyl-1-propanol (AMP)* — Viscosity stabilizer in alkyd finishes containing urea-formaldehyde or melamine resins.

Tris Amino — Potentially useful in manufacture of alkyd resins.

CELLULOSE ACETATE BUTYRATE: *Nitroparaffins* — The only satisfactory medium-boiling solvents for some grades of cellulose acetate butyrate.

POLYURETHANES: *Hydroxylamine* — Can be used in the preparation of isocyanates by forming the hydroxamic acid and reacting it with an acid chloride.

MISCELLANEOUS: *Alkaterge-C* — As a mold lubricant in the molding of plastics. Excellent grinding assistant for hard resins, and as an antifoam agent in polyethylene coating compositions.

Nitrohydroxy Compounds — As hardening agents for proteins such as casein. They are slower gelling than formaldehyde or glyoxal. *Tris Nitro* is the product most often used, although *2-Nitro-2-methyl-1-propanol* and *2-Nitro-2-methyl-1, 3-propanediol* are also effective.

DISCOVER THE NITROPARAFFINS!

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NEWS in BRIEF

More than 15-million square yards of urethane foam will be used annually as interlining for outerwear garments sometime within the next three years, according to P. Oppenheimer, of Brand & Oppenheimer, Inc. The foam interlining provides as much warmth as any insulating material on the market, and is lighter in weight, easier to clean, and longer lasting. Garments can be made lighter and less bulky without sacrificing warmth retention, thus affording more freedom of action and comfort for the wearer.

Proper classification of molding defects by a qualified consultant can establish responsibility and permit the ready settlement of claims without going through the time and expense of courtroom litigation, says H. L. Bullock, engineering consultant (see guest editorial, page 381).

Standards for reinforced-plastic plumbing fixtures are being set up by a committee of SPI's Reinforced Plastics Division. These fixtures include bathtubs, laundry tubs, shower receptors, sinks, and water-softener tanks. When agreed upon, the standards will be submitted to the Department of Commerce's National Bureau of Standards, aiming at final promulgation by the Department as official commodity standards. The standards cover plastics raw materials, fillers, methods of manufacture, structural qualities, washability, weatherability, gloss retention, fungus and vermin resistance, and methods of inspection and test.

Company developments in the plastics industry saw G. S. Plastics, of Cleveland, O., become the newest member of a group of associated firms serving the chemical processing industry. Garlock Packing and U. S. Gasket integrated their sales forces. Monsanto and St. Regis Paper joined in producing and marketing a foamed styrene-paper sandwich material. Polykote, Inc., is a new plastics coating firm in Cleveland, O. A new company, Popular Fiberglass Products, has been formed to make reinforced plastics. Regal Plastic has joined the working arrangement established between Durable Formed Products and Speck Plastics.

Company expansions in the news are plentiful in number. A new building for its structural plastics department will be erected by Aerojet-General. Alpha Plastics has built a new plant for producing PVC pipe and tubing. A new plant for Cab-O-Sil silicon oxide pigment will be constructed by Cabot Carbon near Tuscola, Ill. Diamond Alkali will erect a vinyl chloride monomer plant in Houston, Tex. The new main office and lab of Grace's polymer chemicals division was opened in Clifton, N. J. High Voltage Engineering opened its radiation manufacturing and test facility in Burlington, Mass. Naugatuck Chemical is building a new styrene-copolymer plant near Baton Rouge, La. Electronic testing facilities for the production of reinforced plastic parts for military aircraft are being built in Gardena, Calif., by Zenith Plastics.

New Materials of special interest (see pages 404-5): lead-filled epoxy casting resin; organosol coating for metal surfaces; three non-toxic release agents with controlled viscosity; phenolic molding compound for heavy-duty electrical parts; three corrosion-resistant greases; anti-static cleaner and polisher for plastics; dimethylaminoethyl methacrylate monomer; and thermoplastic polycarbonate molding material.

New Equipment to be noted (see pages 406, 408): 48/64-ounce injection machine; bench-model slitter for plastic sheets; two hydraulic presses; testing unit for scratch, dig, and scrape resistance; and sheet slitting machine.

New Products worthy of mention (see pages 409-11): hook-up wire with fluoroethylene resin insulation; molded polyethylene slide-file case; polystyrene spacers for plastic wall tile; vinyl-coated acrylic trim fabric for aircraft; interlocking molded-phenolic bases for neon signs; line of reinforced plastic process equipment; combination screen-storm door of reinforced plastic; plug valves with tetrafluoroethylene valve sleeves; molded polyethylene splice covers for electric wires; interchangeable, modular plastic-panel system for fluorescent-light ceilings; molded polyethylene corks for beer kegs; motorless carbonator with butyrate housing; and reinforced-plastic decks for boats.

Plastiatrics

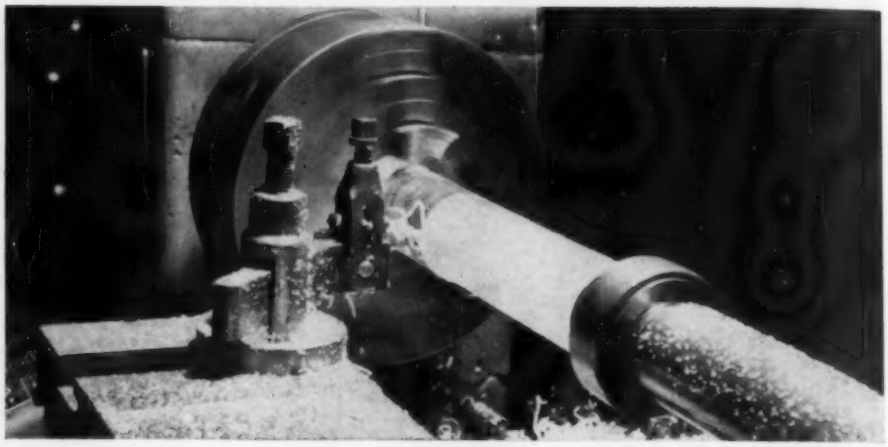
DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

DATA NOW AVAILABLE ON MACHINING AND MECHANICAL FINISHING OF STYRON

MACHINING AND FINISHING OPERATIONS ON STYRON REQUIRE CORRECT EQUIPMENT AND CAREFUL TECHNIQUES

Continuing studies, under the direction of Dow Plastics Technical Service, have resulted in the compilation of extensive data on Styron® finishing. Critical factors such as heat distortion temperature, rigidity, and residual stress of Styron parts have been investigated in an effort to develop proper cutting tools to be used.

Machining of Styron is not difficult when the nature of the material is thoroughly understood and certain basic principles are followed. In most cases, ordinary metal and wood finishing equipment, with some modification, can be used.



Styron is a thermoplastic material which can soften and distort under heat. And, since most machining operations produce heat, mechanical finishing of Styron introduces problems not encountered when working with wood or metal. Surface temperature, for example, must be kept below 140°F. This may be accomplished by reducing friction and providing for proper chip clearance. In many cases, excessive heat generated must be removed by the use of a coolant, either gas or liquid.

Dow Plastics Technical Service has tested drills, taps, threading dies, saws, punching dies, buffing equipment and other tools. Technical Service engineers have compiled a detailed study of all factors involved in the machining and mechanical finishing of Styron parts, which you may obtain by writing for a copy of "Machining and Mechanical Finishing of Styron".

This is only one phase of study under the direction of Dow Plastics Technical Service. Continuing plastiatrics investigations cover every phase of plastics formulation, design, molding and finishing.

For confidential assistance on your plastics problem, and for detailed technical information, write today to THE DOW CHEMICAL COMPANY, Midland, Mich., Plastics Sales Dept. PL 1542K.

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HIGH IMPACT
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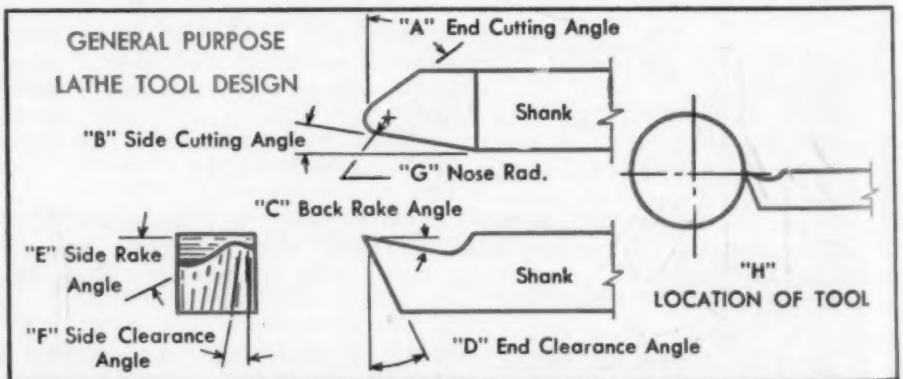
- STYRON 777 (Medium Impact)
- STYRON 440 (Heat Resistant)
- STYRON 480 (Extra-High Impact)

HEAT RESISTANT
- STYRON 683
- STYRON 700

GENERAL PURPOSE LATHE TOOL DESIGN



Mat'l.	A	B	C	D	E	F	G	H
Med. Steel	20°	10°	+8°	6°	14°	4°	3/16	At ℄
Polystyrene	20°	10°	−2°	12°	10°	10°	3/16	2° above ℄

YOU CAN DEPEND ON DOW

PLASTICS TECHNOLOGY

MAY, 1957

EDITORIAL: Relieving the Shortage of Technologists

Much has been written and said in all media of expression on the current shortage of engineers and technologists in all fields of industry, including plastics. The problem is not immediately solvable, and most suggestions have dealt with the need for improving educational facilities and attracting more students into technical fields.

During its annual meeting last November, the Society of Mechanical Engineers, which has a rubber and plastics section, conducted a survey of the registrants on how to relieve this manpower shortage. In addition to the expected suggestions dealing with improvement of high school and college courses in technical subjects, the survey elicited 31% replies suggesting that engineers employed in industry be provided with more technical assistants and clerical help, thereby freeing the professional men for more creative work.

•

This is a thought worthy of serious consideration, especially because it is translatable into more immediate results in relieving the scientific manpower shortage.

Based on personal experience and observation, too many scientists in industry are encumbered with duties and functions that could be performed by technical assistants and even clerical help. American industry, therefore, is not making fullest use of its scientific manpower. Such utilization would be of immediate help in solving the shortage of scientific manpower, and should be supplemented by the necessary long-range program of improving the scientific educational courses and the supply of scientific students.

We are interested in obtaining and publicizing our readers' thoughts on this immediate solutions to the scientific manpower problem. Your comments are invited!

• • •

Compression and Tranfer Molding Forum

The second Engineering Forum column on the subject of "Compression and Transfer Molding." under the editorship of John Woodruff, president of Auburn Button Works, Inc., does not appear in this issue, as originally scheduled, owing to the sudden death of John's father. This resulted in many personal problems for John, and his absence from work at the time when this month's column would have been under preparation. Even under the best of circumstances, the "Compression and Transfer Molding" Forum is hampered by special problems needing the assistance of our readers in that field, as explained in our editorial and John's "Letter to the Editor" in the March issue.

The net result was that John's column could not be prepared in time for publication in this issue, as originally scheduled, but should be available for use in the July issue, the next regularly-scheduled slot for his forum. In the interim, we know our readers join us in offering condolences to John and his family in their loss and grief.

Arthur M. Merrill

Editor

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Stain resistance

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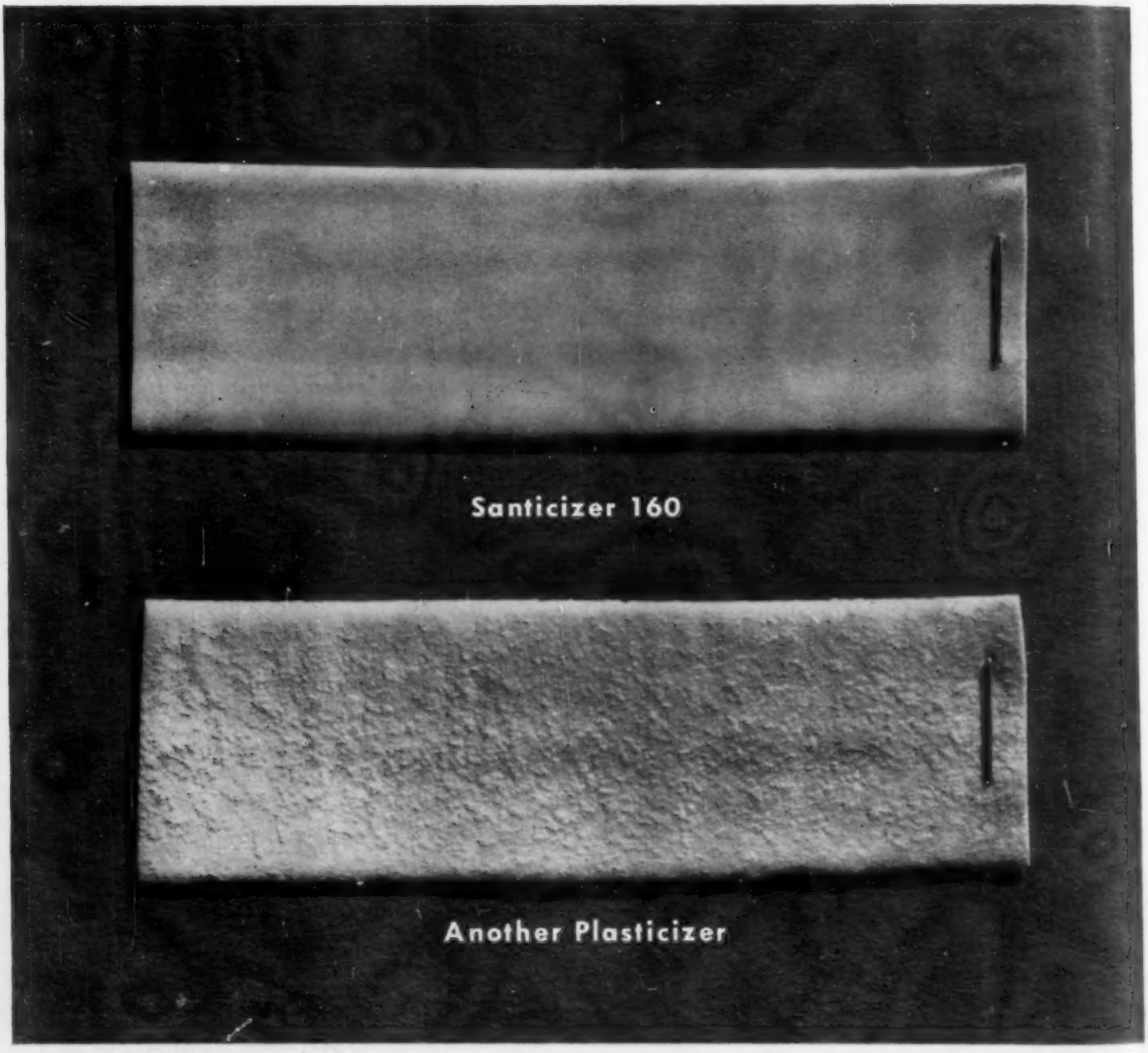

1. Higher filler tolerance

Santicizer 160 holds in fillers better than any other plasticizer. Santicizer 160 is one of the most economical primary plasticizers on the market. Test photos show how its higher filler tolerance results in higher gloss and smoother surfaces.

PLASTICS
TECHNOLOGY

Importance of Mold Rigidity in Injection Molding

Factors influencing mold rigidity are discussed, and their effects described.

R. N. FARRIS and P. J. MEEKS,

Plastics Technical Service Engineers,

Dow Chemical Co., Midland, Mich.

IN any consideration of industrial developments within the last century, the molding of plastics is a relatively new process and injection molding of thermoplastics even more recent. As is true with the development of any art or science, plastics molding has progressed from the very simple to the complex. As applications for plastic parts became more complex and demands are made for greater economy in production, there is increased emphasis on plastic material, machines, and mold design developments.

Each new field of application for thermoplastics brings with it new and more strenuous requirements for dimensional accuracy, stability, strength, sharp parting lines, and freedom from waviness and sink marks. Much effort has been expended in the modification of thermoplastic polymers to provide fundamental properties most consistent with these increased demands.

These basic properties can be used to their fullest extent by improving molding technology, as well as machine and mold design at an equal pace. This latter demand for mold design, and specifically as it pertains to the need for increased rigidity in the injection mold, is the theme of this paper.

The following are some of the applications which have brought to light the importance of mold rigidity. The large areas of refrigerator and air conditioner parts, multiplied by the plastic pressure in the mold of 7,000-12,000 pounds per square inch, result in a high bending and crushing force applied to the mold walls. Any degree of distortion of the mold over these large areas will waste material in filling the resulting thicker section.

The use of thermoplastics in appliance and industrial parts has resulted in closer tolerances and increased dimensional stability, since these parts often are components of complex instruments or machines. The molds for making these intricate parts usually require more side core pulls, long and slender cores, and greater localized temperature control. Such design features subtract metal which would otherwise contribute to the over-all rigidity of the mold.

Any effort to enter the packaging and food container industry, of economic necessity must entail the use of very thin-walled moldings. Thermoplastics have been used successfully in some container ap-

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Rhodes N. Farris was born in Kentucky in 1930, and attended the University of Cincinnati, graduating as a chemical engineer in 1954. He joined Dow after his graduation, and was a chemical engineering trainee in 1954-1955. Since 1955, he has been a plastics development engineer in the firm's Plastics Technical Service. During his school years, he was a member of the American Institute of Chemical Engineers, Tau Beta Pi, Alpha Chi, Sigma, and Phi Lambda Upsilon. Mr. Farris, his wife, and daughter live in Midland, Mich.

Philip J. Meeks is a native of Detroit, and was born in 1929. He received a degree as Bachelor of Management Engineering in 1951 from Rensselaer Polytechnic Institute. He served in the army from 1951-1953, and has been with Dow since 1954. He is a member of the Engineering Society of Midland, Tau Beta Pi, Epsilon Delta Sigma, and Pi Kappa Alpha. Mr. Meeks and his wife live in Midland, Mich.

plications. The use of small, fast-operating, automatic molding machines with molds of maximum rigidity and polymers with easy-flow characteristics is necessary to extend the use of plastics in the container field. The trends toward higher injection pressure to obtain faster filling, and the use of free-flowing polymers with better pressure transmission, combine to place additional requirements on the rigidity of the mold.

Mold Rigidity Factors

Discussions of mold rigidity usually revolve around the bending or bulging of the mold under pressure of the plastic. This paper covers some factors which affect mold rigidity as defined in a broader sense. After a long production run, the parts produced in a given mold may vary significantly from the size and shape of the part as it was designed. Although some of this variance may be attributed to reasonable "wear and tear" on the mold, much of it results from other factors which can be improved by proper design and treatment in the building of the mold.

Ineffective methods of aligning core and cavity result in plastic parts having undesirable variations in wall thickness. Warpage and changes in mold dimensions often are caused by improper and incomplete heat-treating for the relief of stress. The proper choice of steels with satisfactory hardenability properties, and the use of proper hardening techniques are necessary to provide sufficiently high yield strengths to prevent the crushing of cavities and other components of the injection mold.

The permanent deformation by "coining" or "peening" of supporting pillars and back-up plates which are not hard enough to resist this deformation results in a lack of mold rigidity. The dimensional changes which may result from these factors are small at the beginning, but during a long production run may become as significant as the bulging or bending of the mold itself. A further consideration of each of these factors will point out the methods of dealing with them.

Core and Cavity Alignment

Thin-walled moldings require rigid molds because cores and cavities must be kept aligned to provide space for plastic flow. If some weak link in the construction of a container mold of 0.060-inch nominal wall thickness permits the core to shift 0.010-inch, the thin side will now be 0.050-inch thick. This thickness is relatively easy to fill, and the difference probably will not be obvious to the eye. If this magnitude of core shifting were to happen to a piece of 0.015-inch nominal wall, the difference in section thickness would be very obvious because the thin side of 0.005-inch probably would not be thick enough to fill with plastic.

It must follow, therefore, that the thinner the section of the plastic article, the more thought must be given to the design and construction of very rigid molds. The increased time and money spent in manufacturing these molds may produce not only more carefree operation in production, but may be the only means of producing parts at all in some cases of very thin sections.

There has been much discussion in the past about methods of aligning the core and cavity. In order to compare the effectiveness of different locating devices, it would be very desirable to have several molds with core and cavity inserts that would allow different sizes of parts to be molded, and also have different means of locating the cores with respect to the cavities.

Work On Mold Rigidity

The following is a suggested method whereby a comparison of different locating devices can be made. The data used for describing the method are taken

from the operation of a four-cavity tumbler mold with guide pin location, and a single-cavity automatic container mold with a tapered surface locating device. The conclusions from these data should not be carried beyond their significance since the molds and parts are quite different in design. The trends and relative figures, however, will be helpful in discussing the method.

Figure 1 illustrates the four-cavity three-plate tumbler mold with core and cavity inserts that are aligned by means of the guide pins only. Figure 2 illustrates the design of the thin-wall container mold in which both the core and cavity are machined from large billets of steel, and the core is aligned with respect to the cavity by means of the 30°-tapered cone surfaces.

In order to determine how well the cores and cavities were aligned under no clamping force, metal castings of the parts were made, using a low-melting alloy similar to Wood's metal. The variations in thickness of both the container and one of the tumblers are shown in Figure 3.

The plotted curves of the metal castings show the cores are off-center initially; a condition which is unfortunate, but common. Although each curve in Figure 3 shows the measurements made on one molded part, other determinations at different molding conditions showed the same trend and approximately the same amplitude of variation. The values given by these curves are not useful as engineering data, but serve only to illustrate relative variations between the two molds.

The variation indicated in Figure 3 includes both core shifting and bending (or cocking) of the core. It would be difficult, however, to prove exactly what factors in the molding operation are most responsible for the shifting and bending of the core, and to what extent each is effective.

Figure 4 is a suggested method of measuring the amount of variation which might be attributed to each type of mold movement. Here, again, the points represent single determinations, although measurements were made at different molding conditions and the indications of both core shifting and bending were of similar magnitude.

Measurements of wall thickness were made near the lip and near the base of the tumbler. The designed wall thickness was different at these two points, as is shown in the curve for the cast metal part. Since the points plotted in Figure 4 are maximum wall thicknesses, the difference between the two curves at a given distance from the tumbler lip gives the total shifting and bending of the core. If this difference were caused by shifting only, the line representing the plastic part should be parallel (as indicated by the broken line) to the line representing the metal casting. The deviation from this parallel line, then, should be an indication of the bending of the core. Actually, the core does not bend in a straight line, but bends as a cantilever beam.

Although it has been stated that the actual figures presented here should not be interpreted as engineering data, there is no reason to doubt that increasing interest in thin-walled molding will make it desirable, even necessary, to extend and expand such investigations. These data are a strong indication of the marked improvement of rigidity afforded by the individually-located core, using the taper-lock system.

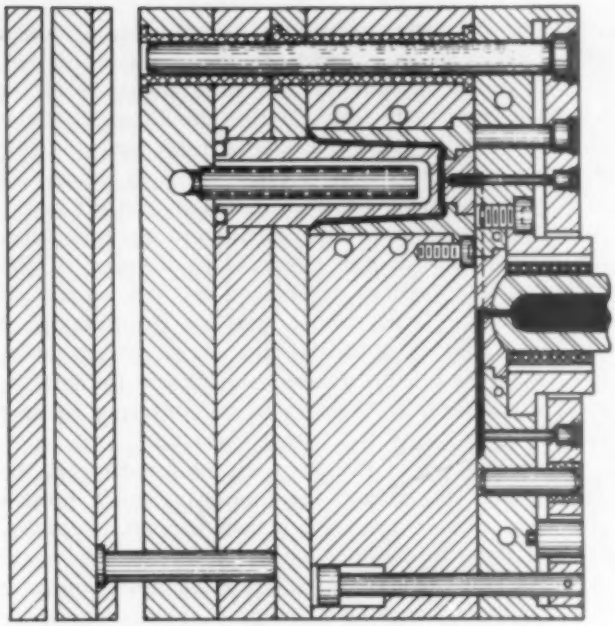

Fig. 1. Cross-sectional drawing of four-cavity, three-plate, tumbler test mold.

Taper-Locating Surface

In order for the taper lock to be effective at all, it is necessary that the fit be tight when the mold is closed. It is obvious that this system will be effective so long as the mold does not open under the force of the incoming plastic. If the container is being molded on a machine whose clamping ca-

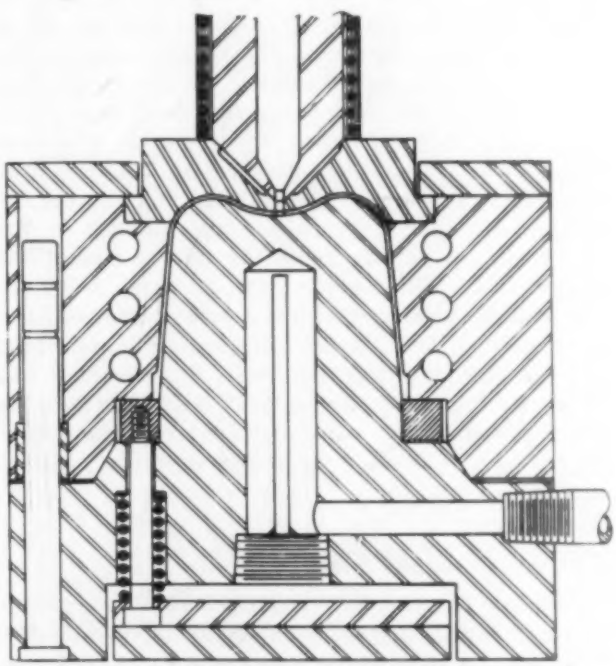

Fig. 2. Cross-sectional drawing of single-cavity, automatic, container test mold.

pacity is very near the product of projected area and mold pressure, the impact of the incoming plastic may be sufficient to open the mold slightly prior to its being completely filled. If this should occur, there is the possibility that the plastic may tend to shift the core while it is open because of slight differences in section thickness. Because of this slight shift in the core, the plastic may tend even more to flow down the thicker side of the cavity. This opening of the mold probably would be caused by the impact of the incoming plastic, rather than by the flashing of the mold after it is full. In the event the mold has been filled and the pressure is sufficient to flash it, there would be little tendency to shift the core because the plastic supports the core all around.

If this opening of the mold will or can happen, the molder obviously should incorporate as much protection as possible in the event it does happen. Naturally, the first thing to consider would be to place the mold in a machine which has sufficient clamping pressure to eliminate any opening of the mold. This is impossible in some cases, and economically undesirable in others. The decision as to whether a larger machine can be used is one which the individual molder must make.

Another approach which should be considered at the time the mold is designed, is the angle at which the taper fit is cut. Figure 5 shows the effect of this angle upon the possible shifting of the core. This information is applicable only in the event the mold is opening during filling. The angle used in Figure 5 is illustrated in the small drawing of the core block. The smaller the angle, the closer the taper would approach a cylindrical fit. Notice that the clearance or possible shift measured in inches is a straight-line function of the extent of mold opening. Thus, assuming the mold does or can open, it would be desirable to make this angle as small as is considered mechanically feasible. Opinions on how small this angle can be will differ between individuals.

There is one more design feature of the mold in Figure 2 that is worthy of comment with regard to core and cavity alignment. The stripper ring has no locating function and, therefore, can be expected to give more carefree, satisfactory operation. Some locating devices have been used which employ a stripper ring with a taper on the outside. The compression of this stripper ring by the closing mold may squeeze the ring out-of-round if it has a large clearance on the core diameter, or may cause the ring to bind if the clearance is small. Assuming the core and cavity are not perfectly aligned (which is a safe assumption) and the tapered stripper ring has sufficient clearance on the core to allow it to operate freely, this clearance will be shifted to the side of the cavity tending to have the thickest wall. Thus, the cavity and core cannot be aligned as well as when the system shown in Figure 2 is used.

Choice of Mold Steels

Although it is necessary to provide sufficient sections of metal and supporting members to improve rigidity, it already has been pointed out that the type and condition of metal used in the mold is of prime importance to the ultimate performance of the tool.

The following discussion is not intended to minimize the importance of design in the construction of molds of high rigidity by suggesting materials of construction which will overbalance design shortcomings. To the contrary, however, the vast majority of the many molds which have proved to be unsatisfactory from the rigidity standpoint probably results from false economy in the design of the mold. It would be impossible to consider design features that would encompass all the mistakes that might occur in injection molds.

Some general considerations of the properties of metals may help in the choice of the proper material for a given job. Perhaps the first decision that must be made is whether the cavity can be machined or if the design is one which can best be hobbed. Usually, the decision to hob a cavity is made because the part has intricate design that is easier to machine on a male hob than in the female cavity block. Hobbing also is very satisfactory for multiple-cavity molds, and molds whose two halves are identical and must match. With the latter, one machined hob can produce many identical cavities.

If steels only are considered, the choice of hobbing necessitates the use of low-carbon steels having low (if any) concentrations of alloying elements. These materials are case hardened by carburizing which gives a relatively soft interior, depending on the amounts of alloying elements. Increasing amounts of these elements provide deeper hardening characteristics and, therefore, the interior is stronger, but hobability is decreased. This stronger interior provides more protection to crushing under high stress.

In the case of high-carbon, alloy steels, it is not necessary to carburize to obtain hardness. The alloying elements in the steels modify the hardenability, and permit deeper hardening of the metal mold parts with oil or air quenching. Deeper hardening is necessary for large-area molds to minimize permanent deformation of the cavity. Opinions as to which steel will be best for a given job will vary between mold builders. It is impossible to produce a steel that combines the best benefits of all types, although some very good compromises are available commercially.

Effect of Hardness

The hardness of a mold has a very great influence on its rigidity. It is not enough to harden the core and cavity blocks to a sufficient hardness to eliminate, for all practical purposes, the permanent set due to

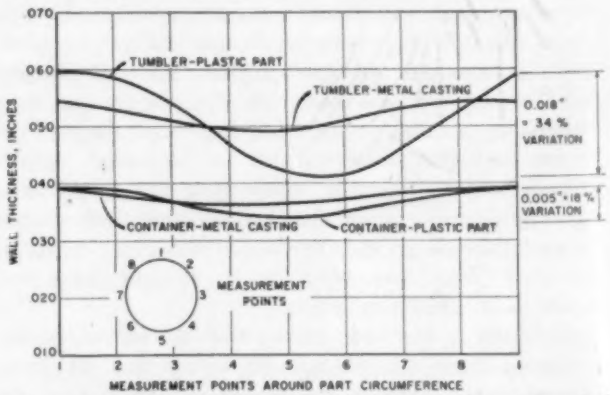

Fig. 3. Wall-thickness variations in tumbler and container test specimen moldings.

deflection under load. The mold maker also must evaluate the effects of other mold parts on the rigidity of the complete tool.

The effects of the other mold parts may be exemplified by the bars and pillars used in the knock-out box. If the bars and plates on which they rest are too soft and, thus, have low yield strength, some permanent set may cause the entire core block to be cocked or shifted. If this happens, all the precautions of aligning the cavity and core, the close machining to tolerances, etc., are of no value. If the entire structure is to be satisfactory, it is necessary to provide a foundation as dependable and rigid as the building itself.

Effect of Modulus

Although increased hardness does improve the apparent over-all rigidty of a mold by increasing the yield strength and, thus, reducing the permanent set of deflected parts, it does not increase the stiffness or modulus of the metal itself. This statement assumes its full importance in a consideration of the most often discussed topic in the subject of mold rigidity; the deflection of cores by pure bending. The modulus of elasticity of steel is 30,000,000 psi., and no amount of hardening or alloying will change this figure by a significant amount.

Dead-shoft hobbing steel is as stiff as the hardest hob metal, and a given load below the yield point will deform each by an equal amount. Steel is the most rigid mold material we have at present, and molds which have rigidity as a dominant requisite should be made of steel. Beryllium copper has a modulus of elasticity two-thirds that of steel and, thus, will deform 1½ times as much as steel when the same stress is applied.

In many cases where pure mold bending is blamed for variations in part wall thickness, the trouble can be traced to poor design or cutting down on the size of core bases so as to mold more parts per shot. In the case of long, thin parts such as vials, it is very important to gate the part at the center of the bottom surface because edge-gating tends to make the bending of the core more pronounced.

Effect of Heat Treatment

Many molds employing intricate designs and very close dimensional tolerances give serious dimensional-stability problems in the heat-treating operation. Large billets usually cannot be forged to uniform stress throughout, and machining destroys the equilibrium of these stresses. If these stresses are very large, heat treating will cause serious distortions that cannot be anticipated in the machining operation. In order to minimize the over-all effect of these stresses, it is common practice to machine the billet all over within about ⅛ inch of the finished dimensions, and to stress-relieve before final machining.

Stress relieving should be accomplished by permitting the annealing furnace to fluctuate 50-100° F. in the stress-relieving temperature range so as to provide mechanical stresses due to thermal expansion and contraction. This mechanical working will relieve stresses more thoroughly than when a constant-temperature furnace is used. A stressed part in a constant-temperature furnace might be compared to a super-cooled solution. The relieving of stresses by the fluctuating furance might be compared to the crystallization of salt from a super-cooled solution by agitation or shock.

Extra precautions and efforts during the heat treatment of the mold steel will pay for themselves in the operation of the mold. By removing as many of the internal stresses as possible, change in shape of the mold is minimized. Working stresses on mold parts are high during the injection molding process, and after many cycles may be sufficient to relieve residual stresses at room temperature that were not removed properly in the annealing furnace, and would result in considerable dimensional change.

Mention has been made of the use of steels which are made to have a combination of the best properties of the different types of steel. In the production of molds that may be difficult to harden because of thin cores or ribs, tool makers often have chosen to use prehardened steels. These prehardened steels, however, are more difficult to machine than unhardened steel. In addition to eliminating the risk of warpage during hardening, tool makers also cite the advantage of being able to repair damages and make design changes after the mold has been used for some time.

Despite these advantages, prehardened steel usually is not hard enough to be polished to a high luster. Prehardening, as such, itself does not assure freedom from a considerable amount of warpage in use. If all the

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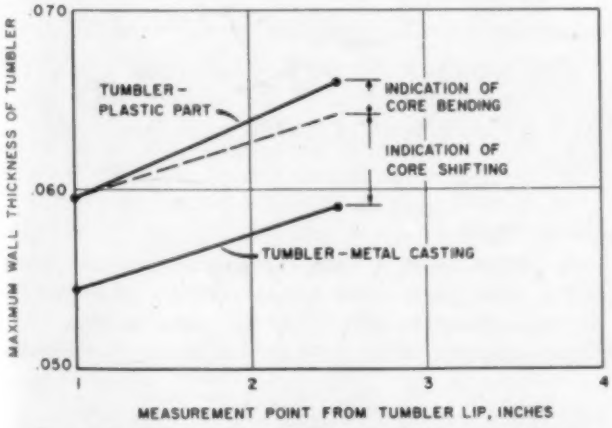


Fig. 4. Components of variations in tumbler test moldings.

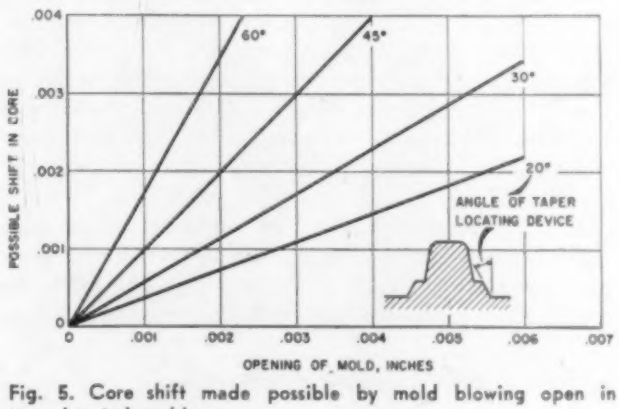
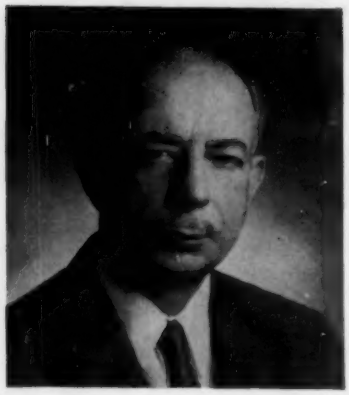


Fig. 5. Core shift made possible by mold blowing open in taper-located mold.



EDWARD FERRARI, *Model Shop Supervisor,*
Industrial Design Section,
Housewares & Radio Receiver Div.
General Electric Co., Bridgeport, Conn.

Plastics in New Product Design

How plastics are used in design operations from appearance models to prototypes.

THE model-making function, as employed by the industrial designer, uses many techniques. An appearance model is used in the primary stages of design to evaluate it in a three-dimensional concept by means of materials which either simulate of actually are those to be used in production. With proper planning, this appearance model also can be made to serve the many other steps involved in product designing. Color studies, consumer testing, packaging requirements, development of manufacturing procedures, and tooling information are some of the functions performed by a model.

In addition, improved techniques make it possible to produce inexpensive prototypes for the engineer to be used for testing purposes. Consequently, the entire management team, working in collaboration, is able to evaluate simultaneously all the functions involved in the development of a new product far in advance of actual production.

We currently have many new materials and processes which can be applied to the basic crafts of the past to produce new methods of product manufacture. The developments in the field of plastics have contributed a great deal. They have given the casting resins and mold materials needed to produce castings with thin-walled sections possessing a high degree of accuracy and durability.

It is the purpose of this paper to show the methods and materials employed in the model-making and casting operations used in developing a model from the design stage to the finished working prototype.

Molding and Casting Materials

There are three different types of mold materials, and five types of casting resins employed in the model-making process. These are used in various combinations to produce the desired result in the mold and casting. These mold materials can be classified as either flexible or rigid. The flexible mold materials include natural rubber latices; synthetic rubber compounds; cold-poured, heat-cured plastisols and elastomers; and hot-melt vinyls. The rigid mold materials, used either singly or in combination, are plaster, reinforced plastics, and electroformed cavities. A composite mold combines flexible and rigid mold materials.

The five casting resins are phenolic, furane, epoxy, amino, and polyester and polyester-methyl methacrylate. Each of these resins is used according to the properties desired in the casting, such as high heat distortion point, impact resistance, dimensional stability, color control, optical clarity, etc.

Mold-Making Techniques

Mold-making techniques are described below for plaster molds, reinforced plastic molds, electroformed cavities, various types of flexible molds, and composite molds.

Plaster Molds

A plaster mold is suitable and economical when only a few pieces are necessary. When no undercuts are encountered in the part, a one-piece mold is sufficient, otherwise it is necessary to design a multiple-

Based on a paper presented at the 13th annual National Technical Conference, Society of Plastics Engineers, Inc., St. Louis, Mo., Jan. 16, 1957.

piece mold. If the model is to be made of a porous material, its surface is sealed with shellac and a parting agent, such as zinc stearate in carbon tetrachloride, applied. The parting lines having been determined, each plaster piece is cast against the preceding part until the entire cavity is complete. Each piece is related to the other parts by means of matching keys, and the sum total of the parts is contained in a retaining matrix.

When a cored casting is desired, the mold cavity is lined with sheet wax to the needed wall thickness. Then, a plaster core is poured into the remaining cavity, and related to the mold by means of matching keys. After this, the core is removed and the wax is stripped from the mold, leaving the space which will be occupied by the casting resin. Hydrocal plasters are best suited for this purpose. After the pieces have been removed from the model, they are sealed with a very light coat of shellac, heated to about 150° F. until dried, and then very thoroughly waxed. This wax should be a hard, white type of wax such as is used on bowling alleys. Finally, the mold is reassembled and the casting resin poured.

Reinforced Plastic Molds

A reinforced plastic mold is made in the same manner as a plaster mold. The pieces of the mold can be made of laminated epoxies, phenolics, or amino resins. Amino resin molds are well suited to casting any resin. If an epoxy mold is to be used for a resin which needs to be heat-cured, it is reinforced by an outer hydrocal plaster shell to insure stability of the mold's shape and dimensions. This plaster shell is made by using the clay-out method, and the eqoxy mold surface is poured so that it adheres to the inside of the plaster shell. More satisfactory results are achieved sometimes when the plastic mold material is different generically from the casting resin.

Electroformed Cavities

An electroformed mold cavity is made by electrolytic deposition of metal on a model until sufficient thickness has been achieved. This thickness of metal, which is the mold cavity, then is removed from the model and encased in a block of a high-temperature casting resin, such as an epoxy or a phenolic (see Figure 1). The cavity is polished and, if desired, can be chrome plated.

If the model is to be cored, a plastic core is cast into the model and related to the cavity by means of guide pins. The procedure used to make the cavity is to prepare a carefully-finished model, preferably plastic in order to better withstand the acids contained in the plating tank. The model then is coated with deposited silver by the reduction method to produce a uniformly electrically-conductive surface. An electrical contact point is established at a convenient point. The entire assembly is placed in a sulfamate nickel-plating solution for approximately 70-100 hours, depending on the thickness necessary, the area to be plated, and the current used.

This type of mold is very accurate dimensionally, and well adapted to use with casting resins into which

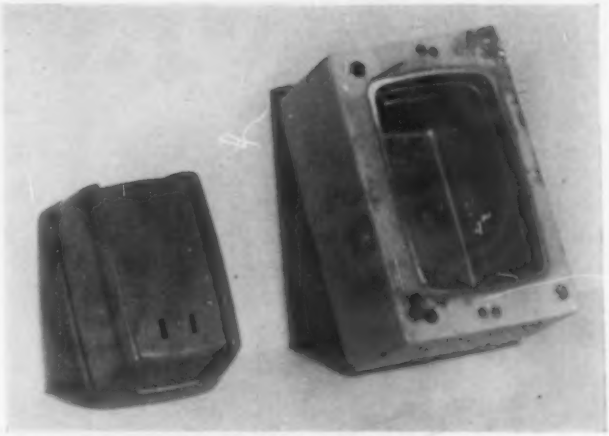


Fig. 1. Epoxy resin casting (left) made from electroformed cavity having epoxy encasement (right).

color has been incorporated. The reason for this is that the surface quality of the casting is such that it produces the same color characteristics that are inherent in a molded production part. Furthermore, since it is possible to apply heat to the mold without danger of distortion, the mold cycle can be shortened considerably. Since the casting is virtually finished upon removal from the mold, little finishing time is required.

Flexible Molds

Flexible molds are used when the intricacies of the part in its structural and decorative details, such as webs, bosses, and embossed or debossed lettering or textures, require faithful reproduction. Parts which have deep draws presenting difficulty in removal of the part from the mold also are cast more readily in a flexible mold.

NATURAL RUBBER LATEX. This was one of the first materials to be used in making flexible molds. In the uncured state, the latex is a water dispersion containing elements which vulcanize the rubber into a flexible

Fig. 2. Prototype model of new fan-heater.

Fig. 3. Turned plaster core of fan-heater housing.

mass. In this form, it is applied to the model in a series of dipped, brushed, or sprayed coatings. Fillers are added to permit rapid build-up after the surface coats have been applied. Larger molds are encased in a plaster matrix. This type of material is useful for making molds without the use of heat.

POLYSULFIDE RUBBER. The polysulfide synthetic rubbers also are useful in directly transposing a clay or plastilene model into plastic. The basic material is composed of three ingredients; the synthetic latex, the curing agent, and a catalyst. This mixture is brushed and poured over the model to which a parting agent has been applied. The mold is allowed to cure at room temperature and is then reinforced by a plaster matrix.

SILICONE RUBBER. These compounds polymerize at room temperature without heat when properly catalyzed. The catalyzed rubber is applied to the model with a spatula to the necessary thickness. When cured, it is removed from the model after a plaster matrix has been made. This material is well suited to embedding small parts in clear, cast polyesters and acrylics.

FLEXIBLE VINYL MOLDS. Flexible vinyl materials are classified in three categories; plastisols, elastomers which

Fig. 4. Clay-up for elastomer mold portion of heater grill.

are cold-poured and heat-cured, and the hot-melt vinyls. The plastisols cure at elevated temperatures (360° F.), consequently, can be used only on non-porous materials such as glass, cermaics, metals, etc. The elastomers cure at lower temperatures (180-220° F.), and are suitable for pouring on plaster, wood, metal, plastics; in fact, any material capable of resisting the curing temperature. The hot-melt vinyls are used when reuse of the material is an economic factor.

The plastisol molds are made by first fastening the model to a background, then placing a well-sealed fence around the model of sufficient height so that it extends above the highest point of the model. This assembly is filled until the model is well covered, is placed in an oven at 350-365° F. and cured until all the plastisol has solidified. The mold assembly is allowed to cool after removal from the oven and, if necessary, can be backed up with a plaster matrix. The mold is released from the model, and is ready for casting without further preparation.

Elastomeric vinyls can be poured into an open mold in the same manner as plastisols are poured. However, since the main advantage derived from using elastomer is the fact that it can be poured and cured on a porous material, a different type of mold is possible. The plaster matrix of the mold is made first and related to the model. The first step in this procedure is to fasten the model on a background, then clay up the model in the following manner: Strips of clay or Plastilene, about ¼-inch in thickness, are placed over the entire model and overlapping some of the background. On this overlap a strip of clay about ⅜-inch square is placed to hold the elastomer firmly in place in the matrix. Cylinders of clay are placed on each highest point of the clay-up to serve as pouring gates and vents.

Hydrocal plaster reinforced with mosquito netting or open-mesh burlap is used to construct the matrix over the clay-up. When completed, it is removed from the model and the Plastilene removed from the matrix. The plaster matrix is dried thoroughly and lightly waxed, as is also the model. The matrix is replaced over the model and the space formerly occupied by the Plastilene is filled with the vinyl elastomer. This assembly is placed in an oven (at 220° F.) for a sufficient length of cure time, depending on the size of mold and thickness of the elastomer. The mold is allowed to cool thoroughly before removing the matrix and elastomer from the model. If the model is cored, the same procedure is followed with the model remaining in the mold cavity. A wax parting agent will prevent the elastomer from adhering to itself. Although it is not necessary to use a parting agent when casting into an elastomer mold, a light coating of wax will prolong the life of the mold.

When hot melt vinyls are used, the same procedure used to make vinyl elastomer molds is followed. However, since the heat used in melting and pouring the vinyl (350° F.) tends to entrap air, this material is poured under vacuum. This is accomplished by sealing the matrix, evacuating as much air as possible, and pumping the melted vinyl into the matrix. When it has cooled, the vinyl is cut on the parting line desired.

Very large molds can be made by using this system.

Composite Molds

A composite mold is one in which a rigid piece mold is used for some portions of the mold, and a flexible material used for other portions. This is done when one portion of the model presents difficulties due to depth of draw which are beyond the scope of a rigid mold. That part of the model, then, is molded of a flexible material.

Model Materials

Phenolic Casting Resins

Since phenolic resins are a result of condensation, it is necessary to store them in a refrigerator in order to extend their shelf life. They are catalyzed by the addition of an acidic catalyst, and can be cured at room temperature by further addition of an accelerator. Elevating the temperature ot approximately 150° F. will shorten the mold cycle. Fillers, such as acid washed asbestos, or ground cork, are sometimes incorporated into the resin. The normal proportion of catalyst to resin is not more than 10% by weight. This is added to the resin and mixed thoroughly and carefully in order to avoid inclusion of air bubbles in the mixture.

After the resin and catalyst have been mixed, a few drops of alcohol are added to the surface of the mixture, These will serve to release and break any air bubbles which may have been entrapped. Then, the resin is poured into the mold. Some phenolic resins are poured more easily when the mold and resin are warmed slightly before pouring. The resulting casts will be capable of withstanding temperatures of about 300° F. and, consequently, are used where molded phenolic parts are specified in production. When reinforced with fiberglass, casting phenolics are good mold materials.

Furane Resins

The furfural ketone resins can be cast into parts having high-temperature resistance (400° F.) and good impact qualities. This type of resin is catalyzed by the use of a carbon filler containing a quantity of para-toluene sulfonic acid. This is mixed in a ratio of 65 parts of catalytic-extender to 100 parts, by weight, of resin. The mixture is allowed to stand until it begins to gel, at which time it is poured into the mold and cured by heat (200° F.). Reinforced castings can be made by adding chopped or shredded fiberglass to the mixture, and pouring it into the two open halves of the mold.

When the resin has gelled to the point where it will not run off, the mold is closed, pressure applied, and the casting heat-cured. This casting will be denser and dimensionally more stable than one which is poured into a closed mold. It also can be used in a wet hand lay-up for tooling purposes.

Epoxy Resins

In the past few years, the epoxies have developed into one of the most diversified resins to be used in model and prototype casting, and many types of resins have been compounded for each purpose. As a casting resin, the viscosity should be low enough to permit the incorporation of fillers and plasticizers. These will tend to diminish the exothermic reaction and produce better dimensional stability and improved impact resistance. Some epoxies are compounded to give good surface resistance to abrasion, such as is encountered with a Keller model. Others are well adapted to laminating for hammer blocks and fixtures.

The most common catalyst used is one with a high amine content. This system permits casting of thin sections that will cure at room temperatures in about four hours. Systems using low-amine catalysts can be cast in relatively large masses. Plasticizers such as polysulfides and polamides impart flexibility and resilience to the end-result. Chlorendic anhydride and acidic catalysts tend to raise the temperature resistance of the epoxy resins.

It is preferable to use a high-temperature epoxy system that will cure at ambient temperatures and requires the application of heat only after the initial cure has taken place. This system does not attack the parting agents on the surface of the mold and, consequently, less difficulty is encountered in releasing the part from the mold.

Since most casting resins have a tendency to be adhesive, mold release is a fundamental problem. The basic release agents used most commonly are hard wax in paste form, silicones in either jelly or liquid form, polyethylene and fluorochemical solutions, and films (such as polyvinyl alcohol, and vinyl acetate). Paste waxes are used on plaster and PVC molds, and also are used as a base for sprayed mold-release agents. Polyethylene and fluorochemical release agents are used on plastic molds into which casting resins are poured. Water-soluble vinyl films are used when casting polyesters in vinyl, plaster, or plastic molds.

Polyester Resins

Polyester resins usually are used in a reinforced laminate consisting of a surface coat and successive layers of glass cloth and resin. The catalyst used normally is a benzoyl peroxide. Cobalt napthanate is used at times to promote the surface cure of some polyesters. If a plaster mold is used, the surface is sealed and waxed and a sprayed coating of water-soluble polyvinyl alcohol applied over the wax. If the mold is of flexible elastomer, polyvinyl alcohol is sprayed on its surface to prevent migration of the styrene monomer content in the polyester, and the plasticizer in the elas-

Fig. 5. Cap piece with cured elastomer removed from the model.

tomer. The latter migration produces inhibition of cure of the surface of the casting. If a plastisol mold is used, no parting agent is necessary to produce good castings.

Clear Cast Resins

There are several types of clear casting resins based on polyesters, styrene monomers, and methyl methacrylate. The polyester-styrene monomer combinations are of the allyl type. Another type is a formulation of methyl methacrylate, polyester, and styrene monomer or vinyltoluene in place of the styrene. Both combinations are catalyzed by benzoyl peroxide and cumene-hydroperoxide catalysts. They are cast best in plastisol or silicone rubber compounds. Plaster and elastomeric molds must be treated in the identical manner used when casting polyesters. However, good clarity can be achieved in plastisol molds because there is no migration of plasticizer or styrene monomer; consequently, no parting agent is needed.

Vacuum Forming

Vacuum forming is used in model work occasionally to produce either actual or simulated parts. The forming is done normally by the drape method over a metal, wood, Masonite, plaster, or reinforced plastic male die. Thermoplastic sheet stocks, such as acrylics, high-impact polystyrenes, acetates, butyrates, vinyls, or polyethylenes, are used. Acrylics are used where clarity of material is essential. Polystyrenes are used when wall thickness and durability are necessary in simulating formed metal parts. Vinyls are used for deep-drawn shapes, and to study inside clearances in a model. Acetates and butyrates are used to represent parts that will actually be produced of these materials.

Temporary Tooling

Reinforced plastic tooling is used occasionally to produce metal parts. Male and female hammering blocks greatly assist and control the making of metal parts by hand hammering. Some parts can be hydroformed in a press over a reinforced plastic male die. Electroforming of metal parts can be done in a female plastic male mold. The surface of the mold is prepared in the same manner used for electroformed molds. When the part has been plated to the necessary thickness, it is stripped from the mold, trimmed and buffed, and finished in copper, nickel, or chromium according to the finish desired. This process eliminates the man-hours involved in the production of a hand-hammered part.

Finishing

Color finishing is done by first matching the color to a standard. Then, the model is sealed and surfaced with lacquers such as are used in automotive finishes. This finish is sanded until the model is smooth. The color is then applied and, when thoroughly dried, is rubbed to a high gloss with rubbing compounds. If a metallic finish, such as polished aluminum, nickel or chromium is desired, the model is first treated with sprayed lacquers, then spray-plated by the reduction method, using the following method.

After the final coat of nitro-cellulose lacquer, made specifically for the purpose of silvering, has been sprayed on the model, it is dried thoroughly. Then, the model is washed with a mild detergent solution to remove any surface oils or dirt, and rinsed thoroughly in clear water. A wetting agent, consisting of soapbark in distilled water, is sprayed on to insure against water breaks on the surface. A mixture of stannous chloride and hydrochloric acid in distilled water is used to produce an acid-sensitizing base. Silver nitrate in an ammonium hydroxide solution is reduced with a formaldehyde solution by spraying with a double-nozzle gun. This places a silver deposit on the model which has the brilliance of a polished metal. A clear protective coating of lacquer is applied over the silver. This coat is tinted to resemble the final color of chrome, nickel, or aluminum. Gold and copper dyes can be added to simulate the two metals.

If the actual metal is desired, this procedure is used up to the step where the silver is applied. At this point, an electrical contact is applied and the model placed in a plating tank where a prime coat of nickel is applied. Then, the model is removed to an acid copper bath where a thickness of copper is plated onto the model, and the plated thickness buffed until smooth. If nickel is required as a finish, the copper is followed by a bright nickel plate. This also can be followed by a chrome plating, if desired.

Making the Prototype

Some of the operations used in making a fan-heater prototype model (see Figure 2) are given below:

(1) Turned plaster cores are made of the motor and heater housings (see Figure 3).

(2) The original plaster model of the fan-heater is turned and fabricated on the plaster cores.

(3) A plaster piece mold is fabricated around the heater shell.

(4) A clay-up is made for the elastomer mold portion of the heater grill (see Figure 4).

(5) A plaster cap piece is made over the clay-up.

(6) After removing the cap piece so the clay-up can be taken out, the cap piece is replaced and the elastomer is poured into the mold.

(7) The cap piece with cured elastomer is removed from the model (see Figure 5).

(8) The plaster and elastomer mold is disassembled and the model removed.

(9) The prepared mold is reassembled and filled with epoxy casting resin.

(10) After curing, the epoxy casting of the heater shell is removed from the disassembled mold.

Conclusions

With the combinations of mold and casting materials in conjunction with improved finishing techniques, it is possible to obtain an infinite variety of actual or simulated materials necessary for the proper presentation of an appearance model.

Although these same processes have made it possible to study the engineering problems involved in a product,

(*Continued on page 382*)

H. L. BULLOCK,
Engineering Consultant
New York, N. Y.

Do You Have to Go to Court?

PRACTICALLY all plastics raw materials are manufactured by large reliable companies to rigid specifications. In the majority of cases, designs employing these materials can be worked up by competent men to produce articles of acceptable value. Under proper manufacturing conditions, these articles can be produced uniformly of satisfactory quality in quantity. This being the case, why go to court to settle questions of fact concerning material, design, or workmanship?

As a plastics consultant and as a member of the National Panel of Arbitrators of the American Arbitration Association, I have had occasion to note the large number of cases concerning plastic quality which follow the long and expensive legal road to settlement. The difficulties are not confined to any one field and the roster, among other articles, has included potato bags, fishing poles, nylon rollers, tableware handles, laminates, and embossed sheeting. Following the usual legal procedure, time is lost waiting for the case to come to trial, high costs are incurred, valuable time is consumed in the courtroom, and factual evidence is obscured or misinterpreted as it is developed under the restrictions of direct and cross examination.

A few companies call in the consultant before approaching their attorney and, in many cases, settlements entirely fair to both parties are arranged on the basis of an engineering report presenting the facts in an orderly and complete manner, which is seldom possible in court under the complex rules governing testimony.

As a consultant's business is primarily to set up production procedures which will produce materials and articles of good quality, he usually is familiar with the causes of defective goods, and can classify defects as to cause, and time-point of inception. Such classification definitely establishes the responsibility for the defect, and furnishes a basis for settling the claims.

As an example of this procedure, a few years ago a consultant was approached by the purchaser of a large quantity of extruded rod which contained a high percentage of defective pieces. The purchaser claimed that the defects were due to poor inspection, faulty workmanship, and, possibly, to the substitution of inferior material. The manufacturer claimed that the rod had been damaged by improper handling and by exposure to excessive heat either during transportation or in storage. Proven use of inferior material would have established a valid claim on the entire shipment, while defects due to faulty workmanship and poor inspection would limit the claim to the material rejected in the purchasers plant prior to use of the rod. Conversely, evidence of damage during shipment or storage would absolve the manufacturer.

Careful examination and tests of representative samples of defective material established the following points:

(1) Except for minor scrap contamination, the correct material had been used.

(2) Some insufficiently-ground scrap material of a higher softening temperature had been added to the extruder feed at various times during the run. This resulted in the production of a rod having knobby surface defects.

(3) Either the omission of breaker plates and strainers or the use of incorrect ones had produced a pulsing extrusion, resulting in a rod of variable diameter. This had allowed incompletely converted material to pass through the die, producing rod having uneven surface.

(4) There were indications that the stock fed to the extruder contained excessive moisture. This produced blisters and other surface defects.

(5) A die of too large diameter had been used for the extrusion of this rod and, as a result, the rod coming from the extruder was stretched excessively to produce the correct diameter. This led to a great loss in strength, and produced excessive embrittlement.

(6) There was evidence that the extruder was operated at too high a temperature and the rod was insufficiently cooled before coming in contact with the conveyor, thus producing out-of-round material.

(7) The material was very heat stable and, in the absence of an actual fire, it could not have encountered temperatures high enough to cause damage either in transit or storage.

These points were developed in detail in a report, and were linked with marked samples which substantiated the findings. On the basis of the findings, a satisfactory adjustment was made; the manufacturer obtaining credit for supplying the correct base material, and taking responsibility for the defective material caused by faulty processing and the inclusion of improper scrap. Court action was avoided and the manufacturer continued as a supplier of the claimant.

It is believed that more plastic companies employ legal advisers than employ engineering consultants and the natural tendency, no doubt, is to turn to the law. If both sides are willing to reach a decision based on demonstrable physical facts, however, a quicker and cheaper decision can often be reached through the services of an impartial consultant.

A word of caution! The plastic field is very diversified and the consultant should be picked with care, as the value of his work lies in his ability to correctly read and interpret the faint signs left in and on the plastic during fabrication, and to recognize the limitations of the material or the design. If you are not acquainted with the proper individual, it would be advisable to ask the advice of the Society of Plastic Engineers, the Society of the Plastics Industry, or the editors of our more prominent plastic publications.

—THE END

Importance of Mold Rigidity in Injection Molding
(*Cont'd. from page 375*)

forging stresses have not been removed by annealing before hardening, these stresses may be relieved by the many molding cycles. Since the prehardened steel dos not have as hard a surface, it also is affected more by abrasion from the plastic.

On the other hand, an oil- or air-hardening tool steel that is thoroughly stress-relieved, machined at a machinable hardness, and then hardened, provides the advantages of economical machining, durability, good finish, and dimensional stability. A good hardening furnace should have accurate temperature control, since hardness is a function of molecular arrangement. The extent to which the desired molecular rearrangement takes place is affected very much by changes in temperature of hardening.

Summary and Conclusions

The trends of the injection molding industry are toward the molding of larger-area parts having closer dimensional tolerances, and toward thin-walled moldings. These complex problems require molds or maximum rigidity. The rigidity of molds entails more than just massive design to prevent bending or bulging caused by high plastic pressures.

Almost every factor that can cause the molded part to be different in size or shape from the design can be considered to be a factor in the rigidity of the mold. Individually-located cores and cavities are much more satisfactory than those located by guide pins in multiple-cavity molds. A very good method of individual location is the use of tapered surfaces or wedge blocks. Warpage and dimensional changes of the mold should be minimized as much as possible by thorough heat-treating procedures.

Proper hardening techniques should be used on steels of sufficient hardenability to provide the inner strength required for adequate rigidity. Supporting and back-up components should be hardened sufficiently to prevent misalignment by "peening" or "coining" of surfaces. It is anticipated there will be much more extensive study in the future, of the variables relating to mold rigidity.

—THE END

Plastics in New Product Design
(*Cont'd. from page 380*)

much research work still remains to be done. It becomes evident that the ideal condition is one in which, by means of inexpensive tooling, it is possible to produce the actual part in the materials and methods that will be used in production.

Inexpensive cavities already have been made by using a metal-filled epoxy casting resin. This is feasible for crtain types of molding materials. In some cases, new metal casting techniques may be employed in making mold cavities and matched dies. Electroformed cavities inexpensively reinforced are gaining widespread use in this field. As new materials are evolved in the laboratories, new techniques will be developed that will expand the function not only of the appearance model, but also the engineering prototype model so as to better serve the product designer in his constant search for better products.

—THE END

Materials and Engineering Performance Evaluation in 1956

C. H. ADAMS, *Manager*
Plastic Product Development
Monsanto Chemical Co., St. Louis, Mo.

THE author of a technical review article covering the year's progress in an industry as dynamic, complex, and challenging as plastics obviously must limit himself to briefly highlighting significant developments as he sees them. The stated relative importance of each of these is necessarily a function of the author's judgment, tempered by his background of experience.

The plastics industry is well-covered by the written word, as those familiar with its literature can testify. It is annually reviewed for the Mechanical Engineer ()*, the Electrical Engineer (2), and Technical and Management personnel (3) of the Plastics Industry. Why, then, a new review? Firstly, the writer feels that it offers an opportunity to communicate with an audience not otherwise reached on technical developments of the plastics industry. Secondly, it allows another viewpoint to be aired, and, finally, it reaches the presses with information that is timely to April 1.

Materials

There is very little under the sun that is completely new. In a strictly technical sense, this also is true for plastic materials. The newness of a plastic is generally related to when it became commercially available in at least development quantities.

The past year saw the introduction of several interesting and potentially important resins. At least one of these is stated to be available in limited supply for a carefully planned, closely-controlled field evaluation program. This approach to the introduction of a product reflects the maturity that has been attained by many segments of the industry. The physical characteristics of these new resins point up another trend—the increased tempo of development of plastic products for industrial and engineering applications.

Polymers of formaldehyde formerly high in nuisance value, low in molecular weight, and poor in heat stability, have been upgraded to useful, strong, stable resins by Du Pont research chemists (4). This thermoplastic, trade marked Delrin, is the one referred to above as being available in limited supply. It's outstanding characteristics are: (1) High strength (tensile, 10,000 PSI.); (2) High heat distortion temperature (212° F. at 264 psi.); and (3) Shock resistance (Izod impact, 1.2-2.3 ft.-lbs./in. notch). Du Pont is forecasting applications for the material which include aerosol bottles, gears and miscellaneous parts for business machines, telephone handsets and bases, pipe, etc. Delrin is a highly crystalline plastic with a specific gravity of approximately 1.4.

The polyolefins were the subject of considerable fanfare in 1955 following the announcements on various low-pressure polymerization processes for polyethylene. The crystalline products resulting from low pressure polymerization in the presence of new types of catalysts are variously referred to as stereospecific, heterogenous, Ziegler, Phillips, Natta, etc. Available in development quantities until a very few months ago (and some of that imported from Europe), low-pressure polymerization in the presence of new enigma. It has been well established that it is initially stronger, stiffer, and more heat-resistant than the branched high-pressure product, although new high-pressure technology has narrowed the spread (5). Problems of poor crack resistance, questionable long-time strength, copper corrosion, etc., have been observed with certain of these new materials. Research and development activity is continuing at a high level, however, and it probably is safe to assume that the linear low-pressure product will soon become an important factor in the over-all polyethylene picture.

Polymers of other olefins have created a great deal of interest including those from propylene, butene, and styrene. Polypropylene (6) apparently has received the most attention. This material has greater heat resistance as its prime advantage over low-pressure polyethylene. While polypropylene is likely to find first large-scale uses in molded and extruded items, there is some indication that it offers possibilities as a fiber. The work reported to date on this material is that of Natta, at Milan Polytechnical Institute.

Polyethylene of upgraded heat resistance, obtained via the high voltage X-ray irradiation route, continues to receive attention. Insulated wire and tape products are commercially available. Its future appears to be a function of the success of current research on the polyolefins and lower cost irradiation.

A polyether (7) based on pentaerythritol and containing approximately 45% chlorine is in the field-evaluation stage. It is an engineering material char-

* Numbers in parentheses refer to bibliography at end of article.

acterized by excellent dimensional stability, low water absorption, high use temperature, and good chemical resistance. Trade marked Penton by Hercules, where it is under development, its forecast uses include water meter components, valves, electric motor components, fibers, and packaging film. It shares at least one property in common with Delrin, i.e., specific gravity of 1.4. It is expected to compete in certain applications with the polychlorofluorocarbons.

Polymethyl styrene was scheduled to become available in March 1957 with American Cyanamid as the manufacturer (8). It is indicated to have superior heat resistance, when compared to straight polystyrene, although available at the same price. A companion product is the acrylonitrile copolymer. The impact of these materials on the polystyrene market is not yet known.

Recent German work on a new group of polycarbonates (9) shows them to be a group of thermoplastics characterized by a high degree of heat resistance, high strength, and transparency. Nylon 6 is entering the domestic scene, and caprolactam is the monomer base. This plastic is rather well established in Europe first as a fiber, and secondly as a molding and extrusion compound.

Existing commercial products have been improved in quality and modified to meet the more exacting demands of the fabrication and ultimate consumer. Vinyl resins now are available that can be extruded into pipe without the use of aids. Polyethylene of higher density via the high-pressure process is being sold for molding into so-called "big ticket" items; the higher density product gives a stiffer molding with better surface.

The intriguing field of epoxies continues to expand as resins are developed for more and more critical engineering uses; e.g., tooling. Research on styrene and related plastics has provided the molder with materials of faster flow, improved toughness of molded parts, etc. Styrene foam has gained considerable momentum. This is due in large measure to the expansion of production capacity, and consequent availability on a large scale of expandable beads. Polyester resins have been modified to give better light aging characteristics and resistance to burning.

The silicones continue in their important role as engineering materials for elevated temperature use. A recent development is a new compound for critical high-temperature aircraft glazing; i.e., glass interlayer (10).

And so the industry advances. Major technological advantages show no signs of diminishing. As in the past, the economic barrier tends to hold back large scale use of materials with unusual properties. It is reasonable, therefore, to assume that the cost problem will receive an ever-increasing share of the research and development dollar.

Appraising Engineering Performance

The heading for this section defines the objective of the kind of testing done today in the laboratories of the industry. It seeks to go beyond the mere gathering of specification data on a product. The shift from testing of specification variety to testing for appraisal of engineering performance has been slow and subtle, but steady.

A good example of this transition is the impact test. Twenty or more years ago, the literature dwelled for the most part on the mechanics of developing or refining a specific technique. Today, the people researching and writing in this area give considerably more thought to the broad questions of shock resistance and toughness or energy to fracture and their definition, before proceeding to the problems of methodology and technique. The literature of the year just past provides ample evidence of this (11).

Another example of this more basic approach to testing is what will be referred to as the "Life Testing" program underway on plastics in the laboratories of a major electrical company. Although details on the complete program are not available, its object is accurately and adequately defined by its title. In carrying out the program, materials are exposed to various heat, light, stress, and chemical environments for long periods. The product of such research is realistic design data.

Studies of processing behavior reflect this philosophical advance of the laboratory program from testing to appraisal of performance. Today, research in this field seeks first to define the major variables of the injection molding, calendering, or extrusion process in terms of basic physical relationships and, then, to measure the pertinent behavior characteristics (12).

The continued high level of interest in plastics as building materials has added impetus to weather-aging programs (13, 14), investigations of the speed effect (15, 16, 17), and creep studies (18). A vital part of the Monsanto "House of Tomorrow" program was an extensive long-term testing program (19) on full-scale components. The resulting data showed the design to be conservative, and demonstrated that plastics can be engineered for structural applications.

The sound polymer program of the Air Force is leading to interesting developments in new types of plastics. Those administering the program recognized more than two years ago that one of the major problems they faced was to evaluate the new polymers resulting from the program. As a result, a "Polymer Evaluation Handbook" (20) project was initiated, and completed in September 1956. The Handbook is designed to aid in the screening evaluation of small samples of experimental materials.

The monumental task of bringing together the world's published literature on the properties and testing of plastics has been done by Lever and Rhys in England (21), and published as a series of articles beginning in March 1955. The authors emphasize the practical aspects of properties and testing. In some areas, they have made substantial contributions to a better understanding of physical behavior; in others, they have limited themselves to a review of standard methods and procedures.

The increasing use and acceptance of plastics as engineering materials is due in no small measure to the ever-better physical behavior definition job being done in the government, academic, institutional, and

(Continued on page 391)

B. H. MADDOCK, *Development Engineer,*
Bakelite Co., Bound Brook, N. J.

How to Predict Extruder Performance with Polyethylene

Steps for the complete prediction of extruder output are developed and explained.

FUNDAMENTAL theories of flow in single screw extruders have been developed and published by a number of observers (1, 2, 3)*. These are generally based on melt extrusion of Newtonian-type liquid or thermoplastic materials under conditions of uniform screw dimensions, constant material temperature and viscosity, and constant pressure gradient in the screw channel. Such ideal conditions almost never exist in practice, so that in attempting to apply the theoretical equations to practical situations, there usually is a need for additional information as to the physical condition and effective viscosity of the material in the screw channel. Such information has been developed for polyethylene, and it is the purpose of this paper to show how this information can be used to predict extruder performance.

Flow Concepts

One of the simplest theoretical concepts is that which describes extruder output in terms of forward flow through the screw channel, opposed by back flow through the channel and through the clearance between the thread and the cylinder wall. The forward flow is the volume of material which the screw will deliver at zero back pressure or with no head on the machine, and is a function of the screw dimensions at the discharge end and the screw speed. When flow is restricted by a die, pressure is developed in the head cavity. This pressure causes back flow through the screw channel and over the screw threads, opposing the forward flow and reducing the output rate.

*Numbers in parenthesis refer to bibliography at end of article.

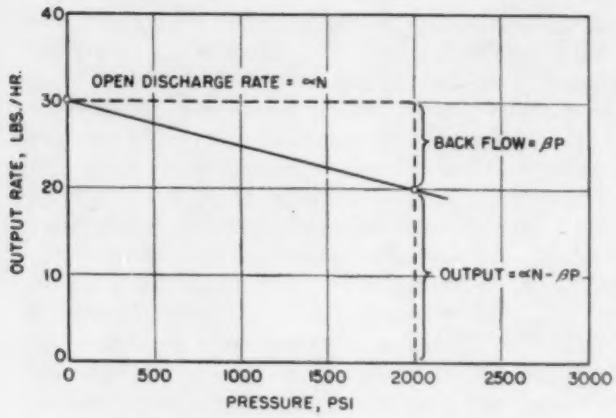


Fig. 1. Effect of pressure on extruder output.

In a well-designed screw, the back flow over the threads can usually be neglected. The back flow through the channel depends upon the chemical dimensions, the viscosity of the resin and the magnitude of the pressure. An equation for the extruder discharge rate can therefore be written in the form:

$$Q = \alpha N - \beta P \qquad (I)$$

where: Q = volume rate of discharge, in cubic inches per second
N = screw speed, rps
P = pressure, psi
α = forward flow constant (screw dimensions only)
β = back flow factor (screw dimensions and resin viscosity)

Equation (1) is a straight line. See Figure 1.

Operating characteristics of the extruder can be fully described if values can be assigned to the factors α and β. Most screws do not have constant dimensions over their full length, nor is the resin completely fluxed or at a uniform viscosity over the entire length of the screw. The most significant area is that near the discharge end of the screw, usually in the last few turns of the thread. In this area, the material is generally assumed to be in a molten state and at a fairly uniform temperature and viscosity.

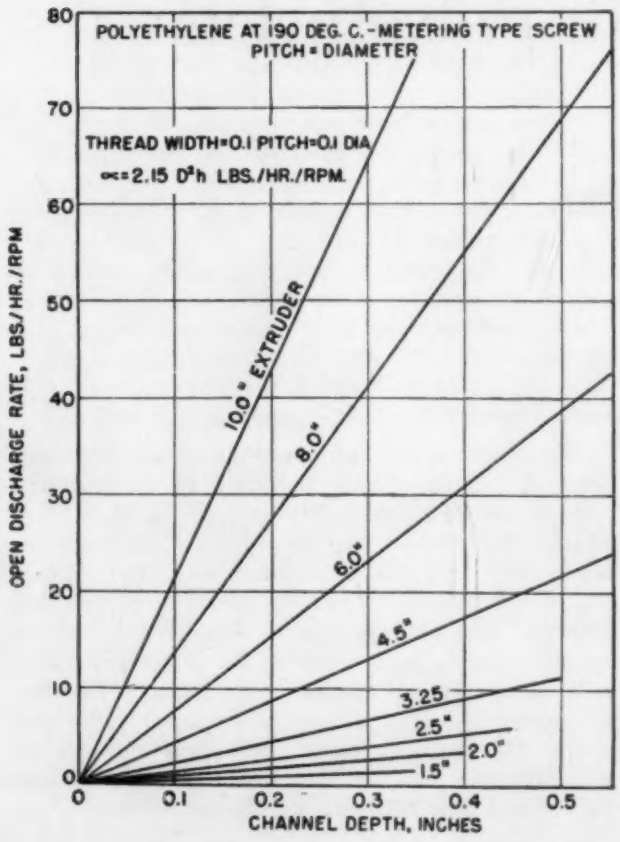


Fig. 2. Effect of channel depth on open discharge rates.

If a metering type screw is considered, in which the dimensions of the last three or more turns are constant, relatively simple expressions for α, in cubic inches per screw revolution, and β, in cubic inches per second per psi., are as follows:

$$\alpha = \frac{\pi D_m h S \cos^2 \phi}{2} \qquad (II)$$

$$\beta = \frac{h^3 S \sin \phi \cos \phi}{12 \eta L} \qquad (III)$$

where: D_m = mean screw diameter (D − h)
h = channel depth in metering section
S = channel width along screw axis = pitch-thread width
ϕ = helix angle = $\tan^{-1} \frac{\text{pitch}}{\pi D_m}$
η = effective resin viscosity in metering section
L = effective screw length (in which material is molten and back flow takes place)

Open Discharge

The open discharge rate can be determined by extrapolating extrusion rate versus pressure curves back to the zero pressure axis. Data so obtained generally agree quite well with values of alpha-N calculated from equation (II).

In the conventional metering type screw normally used for polyethylene, the pitch is frequently made equal to the cylinder diameter and the thread width equal to one-tenth of the diameter. The channel width, S, is equal, therefore, to 0.9D. In this special case, equation (II) reduces to the approximate expression:

$$\alpha = 1.29\ D^3h \qquad (IV)$$

It so happens that for polyethylene at 190° C., one cubic inch per second equals 100 pounds per hour. Inserting this value in equation (IV) and converting to rpm. gives:

$$\alpha = 2.15\ D^3h \qquad (V)$$

The correction for temperature is small, 0.07% per °C. upward for temperatures below 190° C. and downward for temperatures above this point. In most cases, this correction can be neglected.

Examination of equation (V) shows that the open discharge rate and approximate delivery capacity of the extruder at a given screw speed should increase as the square of the diameter and directly with the channel depth.

Equation (V) is plotted in Figures 2 and 3 for conventional extruders from 1.5-10.0 inches in diameter. Open discharge rates can be obtained quickly from these graphs. A 4.5-inch extruder with a 0.125-inch channel depth, for example, would have an open discharge rate of 330 pounds per hour at 60 rpm. (from Figure 3). Similarly, a 10-inch extruder with a 0.250-inch channel depth would have an open discharge capacity of 2,150 pounds per hour at 40 rpm. (from Figure 2).

Back Flow

The back flow is not as readily determined, since it depends upon a number of material and operating variables as well as on the screw dimensions. As before, if the pitch is made equal to the diameter and the channel width equal to 0.9D, the equation for the back flow factor, β, reduces to:

$$\beta = \frac{.0216\ h^3 D}{\eta L}, \text{ in cubic inches per second per psi.} \quad \text{(VI)}$$

or

$$\beta = \frac{2160\ h^3 D}{\eta L}, \text{ in pounds per hour per 1,000 psi.} \quad \text{(VII)}$$

The effects of channel depth, h, and screw diameter, D, on back flow are clearly indicated in equation (VII). The channel depth is particularly significant since the back flow increases as the cube of this quantity. A small change in depth, therefore, can produce a large change in output rate with increasing pressure.

Effective Resin Viscosity

It is at this point that further information is necessary as to the proper value of resin viscosity to be used in the equations for back flow. The viscosity of polyethylene, and most other polymeric materials, is known to be dependent on the rate of mechanical working in the area through which it is flowing. Specifically, the effective or apparent viscosity decreases with increasing rate of shear. Since we are concerned with back flow in the screw channel, the rate of shear in the channel and, particularly, in the metering section is found to be the primary factor involved.

Shear Rate in Screw Channel

The rate of shear in a material bounded by two planes moving in opposite directions is defined as the velocity (inches per second) divided by the thickness (inches). In the case of an extruder screw, this becomes:

Shear rate at cylinder wall

$$= \frac{\pi D_m N}{h} = \frac{\pi}{60}\left(\frac{D}{h} - 1\right), \text{ in sec.}^{-1}/\text{rpm.} \quad \text{(VIII)}$$

A plot of this function against channel depth is shown for commercial size extruders in Figure 4 and against screw speed in Figure 5 for extruder screws having a channel depth of 0.125-inch in the metering section, a common value for screws of modern design. It is seen that the rate of shear in screw channels is generally low, under $\frac{1}{200}$-second. In contrast, the rate of shear in the die may be considerably higher, 10,000, for example, in a $\frac{1}{16}$-inch diameter, $\frac{1}{2}$-inch length rod die extruding at 25 pounds per hour. Thus, the effective viscosity in the screw may be quite different in magnitude from that in the die, and the two areas must be treated separately. Mechanisms taking place in the die will be discussed in a later section.

The manner in which the effective or apparent melt viscosity depends upon shear rate has been determined from extrusion plastometer measurements. This is shown in Figure 6 for Bakelite polyethylene DYNH having a melt index of 2.0. A multiplying factor for resins having melt index values other than 2.0 may be obtained from Figure 7.

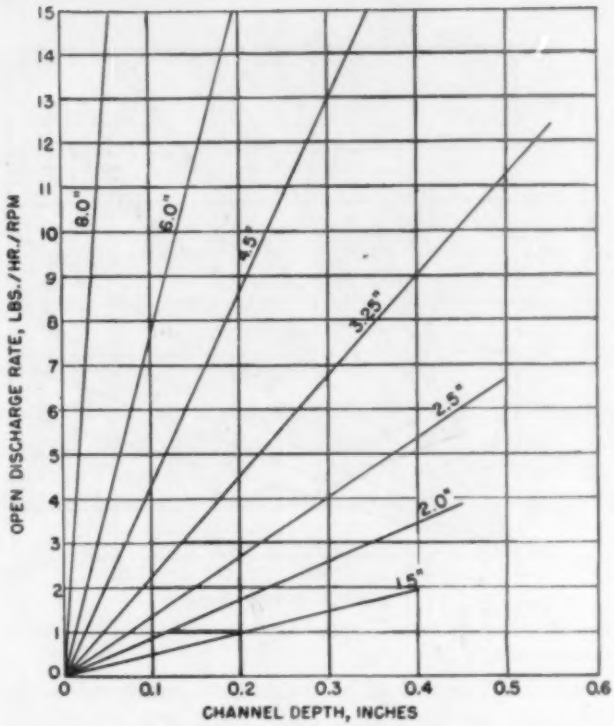


Fig. 3. Curves of Figure 2 drawn to larger scale.

Effective Screw Length

For a known extrusion condition, screw speed, shear rate in the screw channel (from Equation VIII), resin temperature, and melt index (a value of effective viscosity) may be obtained from Figures 6 and 7. This

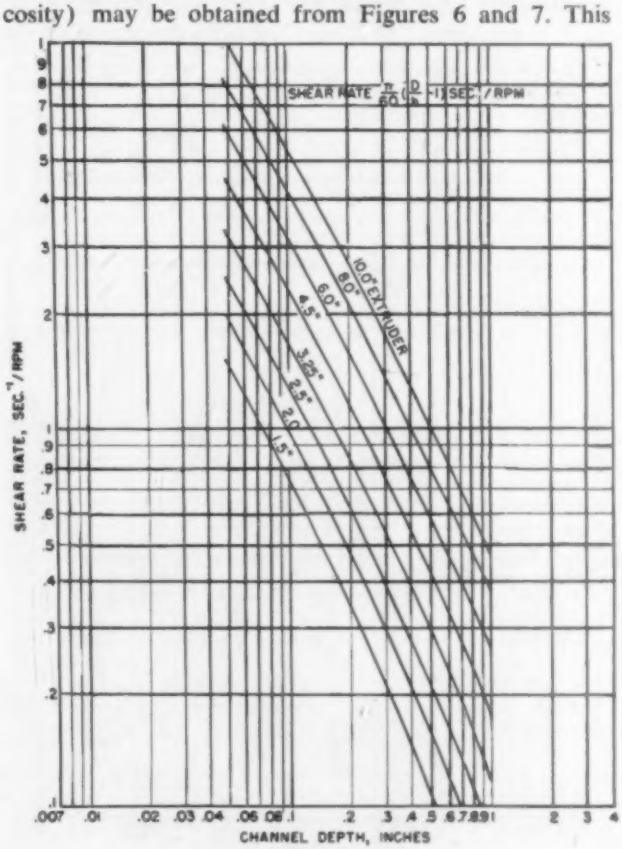


Fig. 4. Effect of channel depth on shear rates for commercial sizes of extruders.

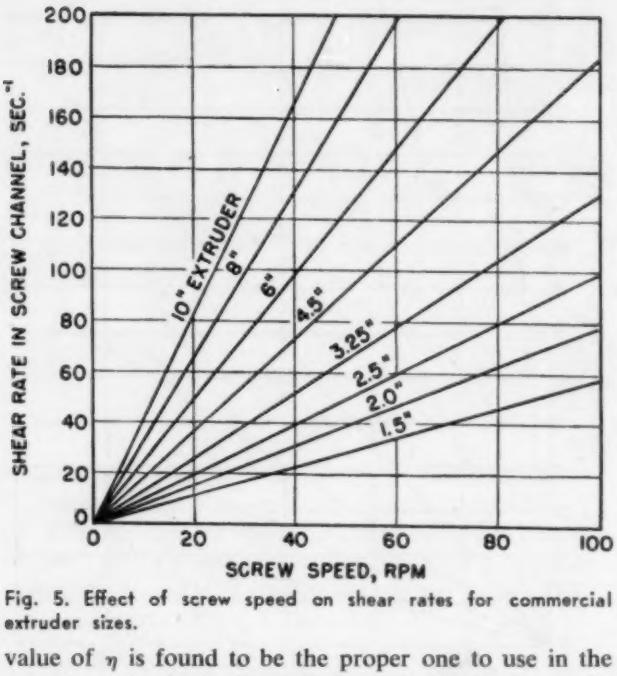


Fig. 5. Effect of screw speed on shear rates for commercial extruder sizes.

value of η is found to be the proper one to use in the equations for back flow (III) and (VII). Since the back flow factor (β) can be determined experimentally from the slope of the rate-pressure curve, it is possible then to solve Equation (III) for the effective length, L, giving:

$$L = \frac{h^3 S \sin \phi \cos \phi}{12 \eta \beta} \qquad \text{(IX)}$$

Calculations of this type were made for a number of metering type screws and operating conditions. In most cases, values of L very close to the length of the metering section were obtained. This appears to indicate that for metering type screws under ideal operating conditions, the portion of the screw in which the material is in a completely molten and uniform state and in which back flow takes place is, indeed, the metering section, and that the length of this section can be used as the effective length in the equations for back flow. It also implies that the feed and compression sections of the screw are performing at optimum efficiency; that is, material is being melted, fluxed, and delivered to the metering section as rapidly as the latter can pump it out.

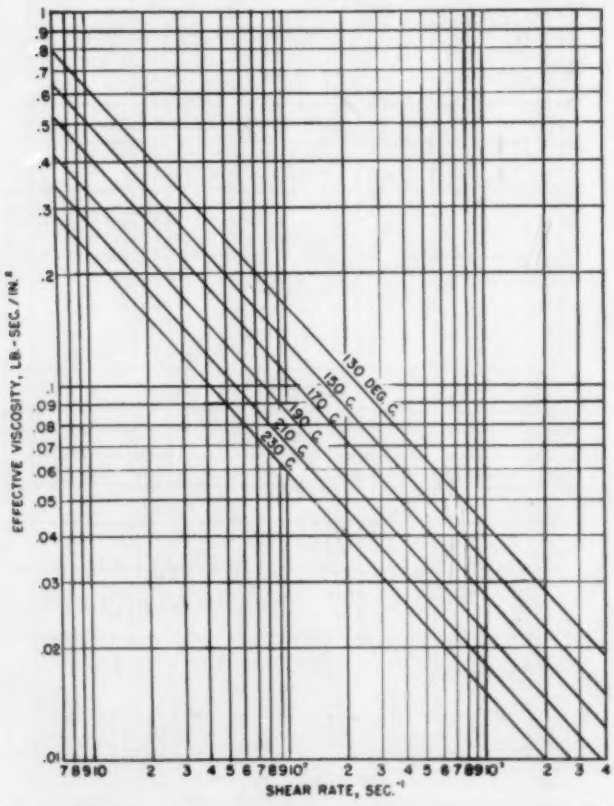


Fig. 6. Effect of shear rate on effective viscosity of 2.0 melt index polyethylene (Bakelite DYNH).

It is not intended to imply that this is the only possible condition of operation. It can be shown, for example, that if the rear cylinder zone is operated at an abnormally low temperature, the heating and fluxing capacity of the compression section may be materially reduced, with a corresponding reduction in output rate. It is also possible, particularly with screws having little or no compression in the zone immediately prior to the metering section, to develop a very high pressure at the entrance to the metering section. This pressure tends to give a forward pressure flow through the metering section and a higher-than-normal output rate, although the resin temperature in this case is likely to be abnormally low. When output rates much different from those calculated from the flow equations are obtained, it usually is for one of these reasons.

Screw Design

To see how well the design and flow theories predict extruder performance, a 1.5-inch extruder with a metering type screw was set up to extrude 2.0 melt index polyethylene at 190° C. through a 1.0-inch gate valve, measuring resin pressure by means of a grease-filled Bourdon gage in the head. Measured and calculated constants for this screw are shown in Table 1.

Table 1. Constants for 1.5-Inch Screw

D = 1.495 inches	ϕ = 18°28′
h = 0.095 inches	S = 1.220 inches
D_m = 1.400 inches	L(metering length) = 4.41 inches
Pitch = 1.470 inches	
α (from Equation II)	= 0.230 cu.in./rev.
	= 0.382 lbs./hr./rpm. at 190° C.
β (from Equation III)	$= \frac{5.92 \times 10^{-6}}{\eta}$ cu. in./sec./psi.
	$= \frac{0.592}{\eta}$ lbs./hr./1,000 psi. at 190° C.

Shear rate in channel = 7.75 sec.$^{-1}$/rpm.

Extrusion rate versus pressure curves were calculated for three screw speeds using the screw parameters of Table 1 and effective viscosities from Figure 6. The results are listed in Table 2 and plotted, together with measured data, in Figure 8.

The agreement between calculated and observed performance is considered very good, speaking well both for the basic theories and assumptions made, and for the validity of the effective viscosity vs. shear rate relationships.

Table 2. Comparison of Calculated and Observed Extrusion Rates.

Screw Speed, Rpm.	Open Discharge Rate, Lbs./hr.		Shear Rate in Channel, Sec.$^{-1}$	Effective Viscosity, Lbs.sec./sq.in.	Back Flow Factor, Lbs./hr./1,000 psi.		Rate at 2,000 Psi., Lbs./hr.	
	Calculated	Observed			Calculated	Observed	Calculated	Observed
27.5	10.5	11.0	21.3	0.220	2.66	2.70	5.2	5.6
55.0	21.0	22.3	42.6	0.146	4.04	4.20	13.0	13.9
82.5	31.5	32.8	63.9	0.114	5.18	5.00	21.2	22.8

Flow Mechanisms in Dies

It has been seen that with proper interpretation of the terms "effective resin viscosity" and "effective screw length," the delivery characteristics of an extruder screw can be predicted with reasonable accuracy as a function of the pressure developed at the discharge end of the screw. This is not a complete definition of extruder performance, however, and it is still necessary to establish the manner in which the die influences the pressure and delivery rate.

The general condition for fluid flow through a die is given by the following relations:

$$Q = \frac{P}{K\eta} \text{ or } P = K\eta Q \qquad (X)$$

where: Q = volume rate of flow, cu.in./sec.;
P = pressure drop across the die, psi.;
η = effective resin viscosity, lbs.-sec./sq.in.; and
K = die resistance constant, in.$^{-3}$.

Values of the resistance constant, K, for dies of different configurations are as follows:

$$\text{Circular Die: } K = \frac{128\,(L + 4D)}{\pi D^4} \qquad (XI)$$

$$\text{Slit Die: } K = \frac{12L}{Wt^3} \qquad (XII)$$

$$\text{Tubular Die: } K = \frac{12L}{C_m t^3} \qquad (XIII)$$

where: L = land length, in.
D = diameter, circular die, in.
W = die width, slit die, in.
t = die opening, slit die, in.
t = wall thickness, tubular die, in.
C_m = mean circumference, tubular die, in.

If the resin viscosity (η) were a constant, it is seen that Equation (X) would be represented by a straight line through the origin on a flow rate versus pressure plot. Actually, the viscosity of polyethylene is not constant for a given temperature and molecular weight, but depends in addition, as previously shown, on the rate of shear in the area concerned (in this case, the die). The rate of shear, in turn, is a function of the velocity through the die and the die geometry. Expressions for the rate of shear in dies are as follows:

$$\text{Circular Die: Shear Rate} = \frac{32Q}{\pi D^3} \qquad (XIV)$$

$$\text{Slit Die: Shear Rate} = \frac{6Q}{t^2 (W + t)} \qquad (XV)$$

$$\text{Tubular Die: Shear Rate} = \frac{6Q}{t^2 (C_m + t)} \qquad (XVI)$$

To determine the proper value of viscosity for use in the die flow Equation (X), the same steps are followed as in the case for flow in the screw channel. First, calculate the rate of shear for a given extrusion rate from

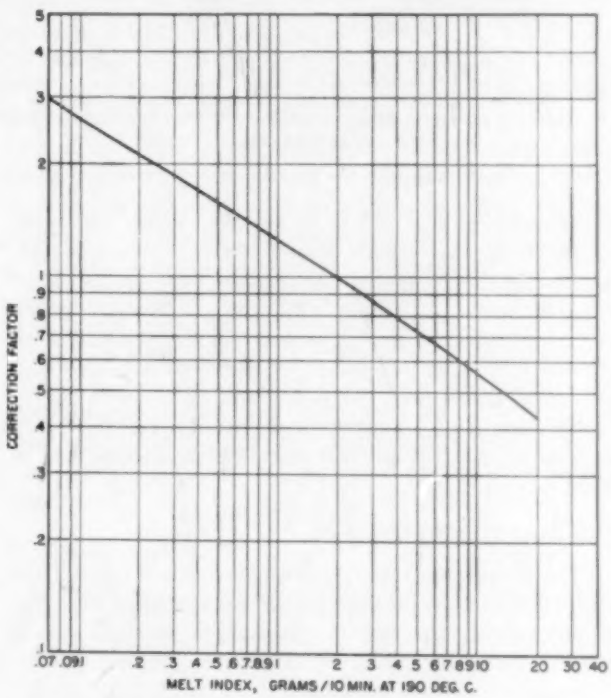


Fig. 7. Multiplication factor for correcting viscosity data of Figure 6 for melt index values other than 2.0.

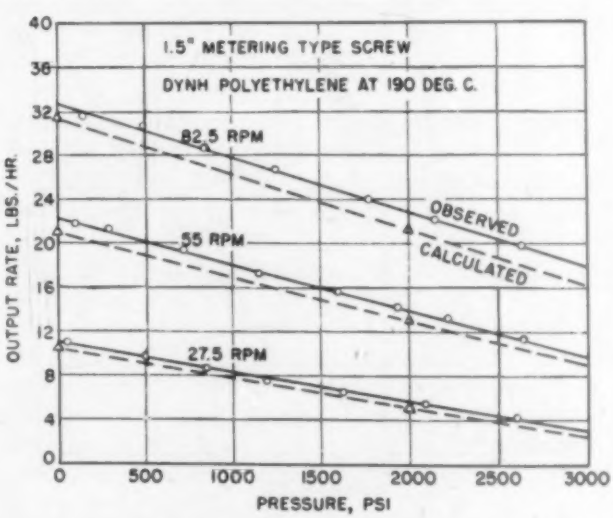


Fig. 8. Comparison of calculated and observed output rates.

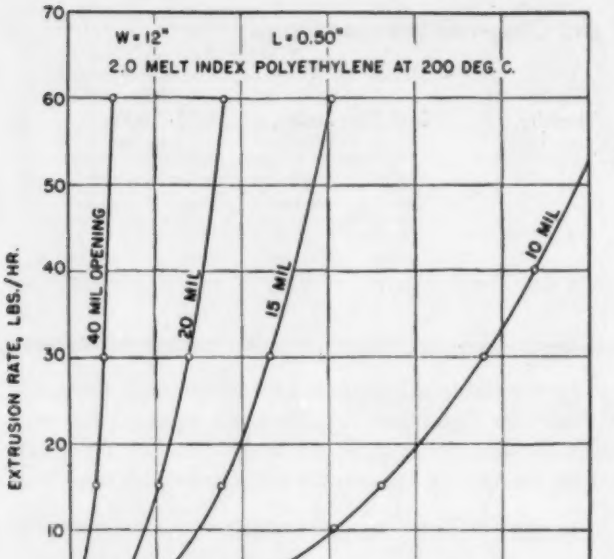


Fig. 9. Theoretical rate vs. pressure curves for a film die.

Equations (XIV), (XV), or (XVI). Using this value of shear rate, determine the effective viscosity for the applicable resin temperature and melt index from Figures 6 and 7. Theoretical rate vs. pressure curves can be constructed in this manner for any die of known geometry. Calculated curves of this type are shown in Figure 9 for a film (slit) die having a width of 12 inches, length of 0.5-inches and openings of 10, 15, 20, and 40 mils, extruding 2.0 melt index polyethylene at 200° C.

Complete Extruder Operation

The calculated rate vs. pressure curves for the die now may be superimposed on the calculated or observed output rate vs. pressure curves for the extruder screw, such as those of Figure 8, to give a complete prediction of operating performance. This is illustrated in Figure 10 for the 12-inch film die and a 2.0-inch extruder with a screw of known characteristics. Also included are experimentally determined data for such a die with a 20-mill opening. The agreement between observed and calculated resins is again very good; a further confirmation of validity of the assumptions made and procedures employed.

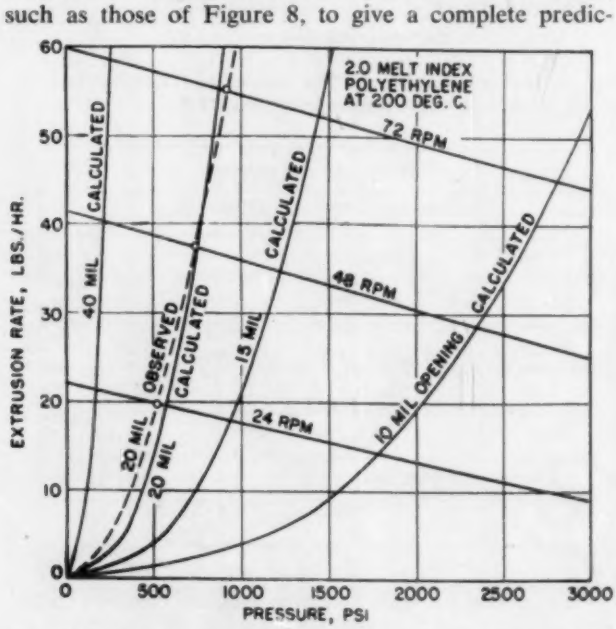


Fig. 10. Operating characteristics of two-inch extruder equipped with 12-inch film dies.

As a further aid in determining the rate of shear in the die and to indicate the order of magnitude of this property in specific die designs, the graphs of Figures 11 and 12 are presented. In Figure 11, it is seen that the shear rate increases rapidly with decreasing die opening, and that values on the order of a few hundred to a few thousand sec.$^{-1}$ would apply in commercial thin film extrusion. Similar relationships are shown in Figure 12 for extrusion through circular rod dies.

The situation with wire coating dies is more complicated, and the mechanics of this system have not been defined completely. Where the insulation is "tubed" on (extruded as a tube and drawn down onto the conductor as it leaves the die), conditions are the same as in tubular film extrusion and the formulas for that type of extrusion apply.

In the more common case, the wire guider pin is drawn back into the head and the material formed around the wire by the die. With the conductor inserted through the die but not moving, the pressure in the head is higher and the extrusion rate lower than under normal coating conditions, due to the added restriction caused by the stationary wire. At present, it is not certain how this system should be treated, either with respect to the rate of shear or the rate of extrusion. Observed effects appear to be intermediate between those of the stationary wire case and one of extrusion through the same die with the wire considered as part of the polyethylene.

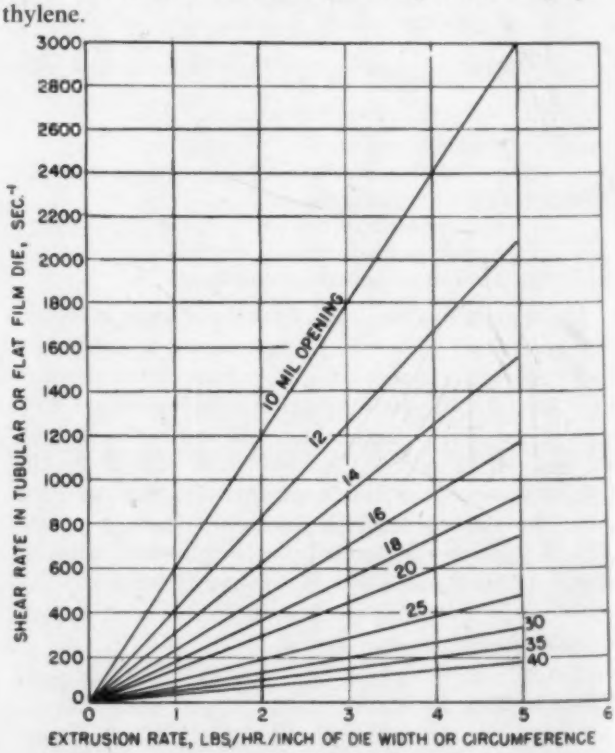


Fig. 11. Shear rates in film dies with different openings.

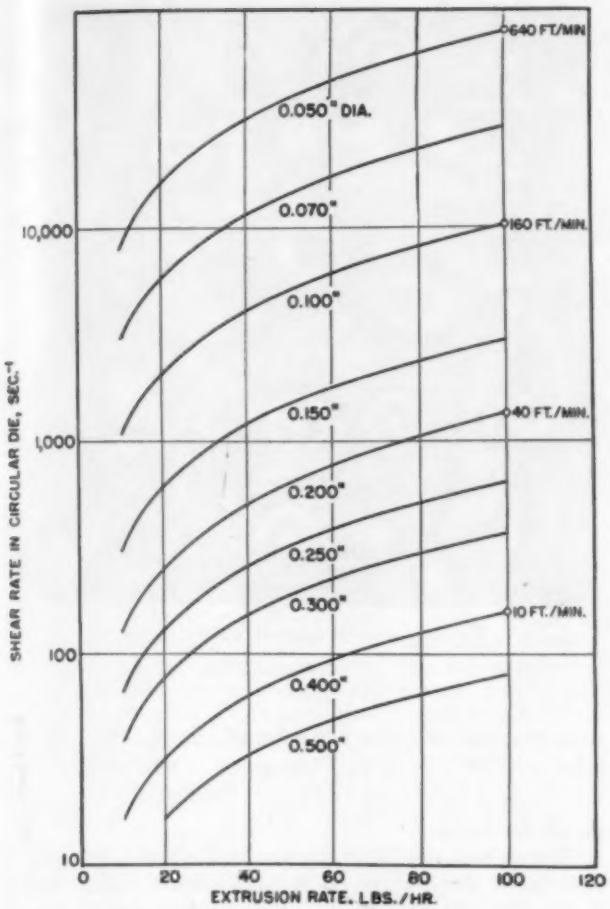


Fig. 12. Shear rate in circular dies.

Predicting Extruder Performance

It has been shown that theoretical flow and screw design equations apply very well in extrusion of polyethylene with metering-type screws when the terms "effective resin viscosity" and "effective screw length" are properly interpreted. The effective viscosity of polyethylene is a function of the rate of shear in the channel or orifice through which the resin is flowing, and data on this property are presented. Since the rate of shear in the screw channel may be widely different in magnitude from that in the die (usually lower), the two areas must be treated independently.

The steps comprising the complete prediction of extruder output (deliveries from the screw and from the die) are as follows:

(A) Delivery from the screw:

(1) Determine the open discharge rate from the screw dimensions (Equation I).

(2) Determine the rate of shear in the metering section of the screw channel for the desired screw speed (Equation VIII).

(3) Determine the effective viscosity in the screw channel for the desired resin temperature and melt index (Figures 6 and 7).

(4) Calculate the back flow from Equation (III) for a particular pressure (2000 psi., e.g.,), using the viscosity from step 3 and the length of the metering section as the effective screw length, L.

(5) Plot the "screw characteristic" on a rate versus pressure plot using Equation (I), remembering that Q in all of the equations is expressed in cubic inches per second, and that for polyethylene at 190° C., one cubic inch/second equals 100 pounds/hour. This will be a straight line for each screw speed.

(B) Delivery from the die:

(6) Calculate the die resistance constant from the applicable Equation (XI), (XII), or (XIII).

(7) Determine the rate of shear in the die from the applicable Equation (XIV), (XV), or (XVI) for several delivery rates.

(8) Determine the effective resin viscosity in the die from Figures 6 and 7 for each rate chosen in step (7).

(9) Plot the rate versus pressure curve for the die on the same plot with the screw characteristic curves. The points where the die curves intersect the screw curves will give the extruder delivery rate and head pressure under the chosen conditions.

The procedures outlined above define the delivery characteristics of an extruder at a specified resin temperature without reference to the manner in which this temperature is produced, or to the variables in screw design and operating conditions which may affect the temperature. They also cover what has been called a normal condition of operation; that is, a neutral or uncontrolled screw in which the heating and fluxing capacity of the compression section is equal to the pumping capacity of the metering section.

The procedures are useful in predicting the performance of existing equipment, and in the design of screws and dies for specific applications. The exact manner in which other design and operating factors, such as chanel depth, screw temperature control, resin variables, etc., affect such properties as frictional heat development, rate variability and product quality have been studied and will be presented in future publications.

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—THE END

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(*Continued from page 383*)

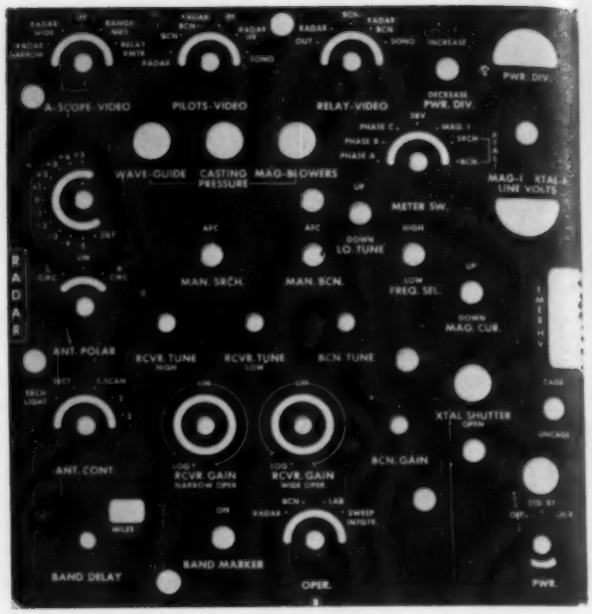
industry laboratories. There is every reason to believe that this trend will continue.

The effect of nuclear radiation on plastics now is receiving the attention of a large and active group in ASTM Committee D-20 on plastics. There has been some publication activity on radiation damage to plastics. (22)

Domestic and international (23) standardization activity continues to expand. It is gradually broadening its scope to include manufactured plastic items such as pipe and fittings, reinforced sheets, etc. Progress in this latter area is slow because of complexity in drafting specifications that spell out performance requirements.

(*Continued on page 392*)

Plastics Capture Aircraft Instrument Panel Market



Typical, edge-lit aircraft control panel.

Almost all of the instrument and control panels on military and commercial aircraft are now plastic, due primarily to the phenomenon of edge-lighting. Pioneered by G. Felsenthal & Sons, Inc., Chicago, Ill., the edge-lighting technique operates on the principle of light's reflection from a polished surface. Rays, cast from a light source within the panel, are reflected internally until they encounter areas where the surface polish has been disturbed by sanding, machining, or painting.

Although any transparent material will transmit light in this manner, acrylic plastic does it most efficiently because of its almost perfect transparency. Red light is usually used, since it is not harmful to the eyes and allows for a high degree of "dark adaptation." Panels illuminated with red light do not blind the pilot's eyes to dimly-lit ground markers, or to possible enemy aircraft.

The manufacture of a plastic control panel begins with the silk-screening of markings or calibrations onto a thin sheet of rigid, white translucent, vinyl. Black acrylic paint is used, and covers all of the sheet except the areas where light is to be channeled through the panel markings.

The second step involves sandwiching the vinyl sheet between a thick layer of acrylic, which serves as the light-transmitting medium, and a protective layer of elastomeric, scratch-resistant vinyl. The laminate is trimmed to size, and the back surface and edges are painted with white acrylic paint to increase light reflectance. The white coating is followed by a coating of black acrylic. This prevents any light from escaping to areas where illumination is not desired.

Tiny electric bulbs are set in holes drilled through the panel. These are capped on the panel surface to prevent light from escaping. Transparent, red filters encircle the bulbs. At night, the pilot sees nothing on the board but red markings. In daylight, the panel markings are seen as white on a black background. —THE END

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PLASTICS TECHNOLOGY ENGINEERING FORUM

Mold Making and Tooling

Edited by:
ERNEST J. CSASZAR
Vice President
Eagle Tool & Machine Co., Hillside, N. J.

Automation in injection molding certainly has captured the interest of the present-day molder of thermoplastics. Many injection molders are presently molding parts by varying degrees of automation on many different types of injection molding presses, both old and new.

The latest designs of injection molding presses involving features of low-pressure closing, high injection and closing speeds, and high plasticizing capacities have done much indeed to further the techniques of high-speed automatic molding. However, there still are a number of automation features being built into molds that might better be incorporated as part of the press. This would result in at least two major advantages: Firstly, building a certain action into the press would be a one-cost item and part of the press, whereas a similar detail as part of a mold must be duplicated with each mold and its cost carried by each mold. Secondly, having a certain type of action as part of the press would have a tendency to standardize the press components as well as the mold components, again reducing the cost by opening the door to use of mass-produced parts instead of special mold designs.

A typical example of this could be an automatic degating type of injection mold of three-plate construction. In operation, this type of mold employs the principle of molding the parts in the conventional manner for ejection. However, the runner system within the third plate is set up so that it will stick to the stationary portion of the mold, on the mold-opening stroke, thus automatically breaking it away from the molded parts. At the completion of the press' opening stroke, then, the runner system is mechanically ejected from the stationary half of the mold by the action of pull-bars that operate the ejector system built into the stationary mold half.

Most present-day injection presses do not have standard knock-out mechanisms on the stationary or injection side of the press and, therefore, the entire runner system, the knock-out mechanisms, and their actuating features must be built into the mold. Furthermore, the function of this knock-out system is limited to the single opening stroke of the press. This condition raises other problems since sometimes it would be desirable to have the runner knock-out system act independently of the movable press-platen movement.

The suggestion, then, is to provide the injection molding press with an independent knock-out actuating member on the stationary half of the press. This would be constructed so as to be hydraulically operated (by the press' own hydraulic system) to be double acting (both forward and backward), and to have its own timers for setting the knock-out action to act independently of the press opening, except for safety features.

In this way, a more positive runner system knock-out would exist. Furthermore, this would greatly simplify the mold set-up, since the pull rods that otherwise would be needed to actuate the knock-out assembly could be eliminated, and the great care needed to set the stroke of the press in conjunction with the full-open position of the mold would no longer be a limiting factor.

Use of the hydraulically-operated, independently-controlled mechanism on the stationary half of the injection press would not have to be limited to actuation of runner knock-out systems. In an injections mold of a more complex nature, it is necessary sometimes to hold certain plates together for a portion of the opening cycle to accomplish a stripping or similar feature. Usually, this is done with side latches, detents, or other spring-pressure set-ups. Unfortunately, these mechanisms wear, go out of adjustment, and require constant attention. This action could very well be picked up from the hydraulic unit described above and, with its own timing features, be adjusted into the overall cycle of the mold to operate at the most advantageous portion of the cycle. No doubt, there also are many other uses that mold designers would have for this type of mechanism if it were available. —THE END

Reinforced Plastics

Edited by:
HARRY T. DOUGLAS,
Executive Vice President
Lunn Laminates, Inc.
Huntington Station, N. Y.

In this month's column, I will cover the first part of a letter that mentioned two of the contributing factors to failures in he reinforced plastics industry.

"Dear Mr. Douglas:

Your views were timely, especially about hindsight always being more practical than foresight in the precarious reinforced plastics plant. I was one of the top executives in a fairly large reinforced plant that recently went out of business. From my experience, the trouble with the industry is deliberate underbidding because of anxiety to get the contract; and careless under-estimating, with various items inadvertently left out of the original estimate. When this happens in a succession of cases, the reinforced plastics molder is doomed. Emphasis should be made repeatedly by leaders in the industry through articles and speeches to help the reinforced plastics molders avoid these two unnecessary evils." (Name withheld as requested).

This reader's letter points out two of the major reasons for the disturbing number of failures during the past year in the reinforced plastics field. I conducted a survey among some of the past members of various plants which went out of business, and discovered interesting case examples of how some of these incidents contributed to the over-all failure picture.

Let us take the first "evil" mentioned here, that of underbidding to get a contract. Often, deliberate underbidding is made with the excuse that it is for a "prestige" job, and supposedly means more to the reinforced plastics molder in reputation and publicity than in income.

This is definitely harmful to the molder's future, his customer's interests, and to the reinforced plastics industry in general. It is harmful to his plant's operations because he has to skimp somewhere in order to produce the part on which he underbid. Not only does this lower the employees' morale and induce a lack of incentive and responsibility but it also soberly points out to them that any product produced at a loss means less income for them. It becomes obvious management cannot increase their pay if a number of these "prestige" jobs just break even or are performed at a loss.

In the skimping, quality standards undoubtedly suffer and the customer receives an inferior product. No practical-minded customer would expect the molder to manufacture a part at a loss. This injures the customer's future source of supply since he cannot rely on that molder to continue furnishing him with such low-cost merchandise. His future plans for successfully marketing and selling the products are endangered.

Also, the industry as a whole suffers since plants going out of business reflect on the instability of the field. Prospective customers will think twice before turning

(Continued on page 399)

News of the Societies

Executive Committee of Western Section, SPI National Plastic Tooling Division: (left to right, front row) treasurer, L. Costanza, Douglas Aircraft Co.; corresponding secretary, P. Nielson, Shell Chemical Co.; chairman, T. Guerreiro, Northrop Aircraft Co.; alternate chairman, N. Hastings, Hastings Plastics Co.; secretary, H. Rumenapp, Douglas Aircraft Co.; (left to right, back row) casting test methods, R. Morozowicz, Douglas Aircraft Co.; engineering standards, G. Adams, Adams Engineering Co.; handbook, L. Oye, Rezolin, Inc.; fabrication techniques, W. Cornner, Rezolin, Inc.; and laminate test methods, L. Lyle, North American Aircraft Co.

SPE New York Section Sponsors Regional Technical Conference

SPE's New York Section held its second regional technical conference on April 3 at the Hotel Statler in New York City. Theme for the conference was "Plastics in Building," and approximately 200 members and guests were in attendance. Lunch and dinner were served.

Two simultaneous sessions were held during the morning, and a single session in the afternoon. Edward T. Crinnion, Deputy Commissioner of Housing for the City of New York, addressed the group at luncheon on "New York City Building Standards." Jeffrey Aronin, architect, was the dinner speaker. His topic was "Buildings of Tomorrow." Abstracts of available papers follow:

Henry Peterson, E. I. du Pont de Nemours & Co., Inc., opened the thermoplastic session wth a talk on "Acrylics in the Building Industry." The essential characteristic of rigid acrylics, whether clear or colored, is outdoor durability. Other features include crystal clarity, low-light absorption, high strength, color stability, light weight, and non-shattering properties. Mr. Peterson then showed 41 colored slides of acrylic applications.

"Vinyls in the Building Industry" were discussed by Malcolm Seymour, General Tire & Rubber Co.'s Bolta Products Division. The fundamental reasons for the commercial success of vinyls in the home are color, design, toughness, and washability. The most important use of vinyls in the building industry is the manufacture of flooring, both roll goods and tile. Other interesting applications for vinyls include translucent luminous ceilings, decoratve wall panels, and wall coverngs.

"Woven Plastic Fabrics" was the topic of a talk by J. F. Nicholl, Lumite Dvision of Chicopee Mills, Inc. These materials do not include the synthetic fibers, yarns, and textiles; but only the monofilaments and continuous filaments. These are saran, Dow's vinylidene copolymer; polyethylene, both old and new; nylon monofilments; vinyl-coated fibrous glass; and Teflon monofilaments. Applications include screens, outdoor upholstery, and filters,

In the thermosetting session, Charles Proudfit, Celanese Corp. of America, addressed the group on "Polyesters in the Building Field." Synergism can be obtained in industrial structures by combining the thermosetting characteristics of polyesters with the high tensile strength of glass fibers. Reinforced polyester-sandwich laminates are used widely as semi-structural members, and as stressed-skin facings. Desirable properties offered by reinforced polyester sheets and laminates include high elastic modulus, rigidity, impact strength, durability, optical properties, formability, and workability.

"Glass Reinforcement for Structural Plastics" was discussed by R. G. Adams and Ralph Sonneborn, Owens-Corning-Fiberglas Corp. Most glass fibers used for the reinforcement of plastics are made by mechanical pulling, which produces a continuous fiber. These filaments are collected and sized, after which they are treated with a lubricant, an adhesive, and a coupling agent or primer. They are used as reinforcing mats, rovings, chopped strands, milled fibers, yarns, surfacing and overlay mats, woven fabrics and woven rovings.

John W. Hull, National Aniline Division, Allied Chemical & Dye Corp., spoke on "Urethane Products in the Home of Tomorrow." Non-friable, dimensionally-stable, and capable of being foamed-in-place, the urethane foams offer many possibilities in the field of construction. High Compressive and shear strengths indicate their desirability for use between sheets of thin panelling in thermal insulation and to cut convection losses. Flexible foams have resilience, but no "fight-back" after initial resistance. Densities and compression resistance can be varied to suit different cushioning needs.

The first afternoon speaker, Jane Fiske Mitarachi, *Industrial Design*, spoke on "Designing with Plastics." She noted that certain properties of plastics are not to be found in any other material, and stressed certain shortcomings of plastics when used as substitutes for wood or metals. Property data should be made readily available to designers who, in turn, should base their design considerations on these factors.

"The Use of Plastics in Contemporary Interiors" was covered by Adi Fitzner, Fitzner Associates. He discussed their practicability and visual appeal from the floor to the ceiling. This includes vinyl flooring, vinyl wall coverings, acrylic and reinforced-plastic room dividers, laminated plastic table tops, phenolic drawers, molded plastic chairs with vinyl upholstery, and lamp shades.

"Reinforced Plastic Piping and Plumbing Fixtures" was the topic of a talk by James S. Lunn, Lunn Laminates, Inc. In addition to the actual piping, which is durable and corrosion-resistant, reinforced plastic fixtures offer the advantages of unit molding. This is particularly practical for portable buildings and other structures where light weight and impact resistance are of special importance. Low tooling costs make possible the manufacture of diverse shapes, sizes, and colors. The major problem to be faced is presented by existing building codes which must be modified before large-scale home applications can be envisioned.

"Recent Developments in the Field of Plastics for the Lighting Industry" were discussed by J. B. Orr, Sheffield Plastics, Inc. He covered the use of plastic panels and pans for fluorescent lighting, especially those of styrene. Cheaper than acrylic, styrene panels have a tendency to yellow and embrittle with exposure to ultra-violet light. Sheffield has developed formulations that produce flexible pans, stable to ultra-violet.

The following talks were presented, but

the papers are not available for abstracting: "Polyethylene in Home Construction," Fred Sutro, Spencer Chemical Co. "Phenolics," Douglas M. Roe, Bakelite Co.; "Melamines," W. F. Drees, Formica Division, American Cyanamid Co.; "Plastic Building Components," Luigi Contini, Monstanto Chemical Co.; "Plastics and Building Codes," Frederick J. Rarig, Rohm & Haas Co.; and "A summary of New Applications and Repair of Existing Structures,"Clayton Meyers, Bakelite Co.

CCDA Annual Meeting

The thirteenth annual meeting of the Commercial Chemical Development Association was held on March 28, at the Hotel Statler in New York City. Theme for the meeting was "Plastics," and the background for the program was established in the opening talk "Plastics Today" by R. C. Weigel, Du Pont polychemicals department.

Mr. Weigel pointed out that many. conventional materials of construction are in short supply, and have become very expensive to process. He predicted that the plastics industry would adopt high-speed, large-unit operations far beyond the present concepts, and stressed that plastics should be considered in new concepts, not just in terms of conventional materials.

Theme was amplified further in a talk by B. J. C. van der Hoeven, Koppers Co., entitled "The Raw Material Supplier;" and in a talk by John J. O'Connell, Consolidated Molded Products Corp. and board chairman of the Society of the Plastics Industry, entitled "The Fabricator." The luncheon speaker, Francis X. Kiefer, editor of "Department Store Economist," spoke on the subject, "The Consumer Looks at Plastics," pointing out areas of misinformation and lack of information about plastics on the part of the average end user.

The afternoon session consisted of four panel discussions on the following topics: "Is the Consumer Happy with Plastics?" "The Marketing Job Ahead in the Plastics Raw Material Industry," "Where Are the New Markets for Plastics," and "Field Development and Technical Service in the Plastics Industry." Leaders of the plastics industry, as well as retail and consumer representatives, served on the panels.

The annual award for outstanding achievement in the field of commercial chemical development was presented at dinner, to Andrew E. Buchanan, Jr., general manager of Du Pont's textile fibers department, in recognition of his leadership in commercializing Dacron polyester fiber.

New officers for the Association are as follows: president, L. E. Johnson, International Nickel Co.; treasurer, W. J. Riley, Food Machinery & Chemical Corp.; and executive secretary, G. A. Harrington, Amoco Chemicals Corp. Directors are W. M. Barnes, Southwest Research Institute; and W. A. Woodcock, Carbide & Carbon Chemicals Co.

SPE New England Conference

Another regional technical conference will be held under the sponsorship of the Society of Plastics Engineers, Inc., on June 14. The Society's Eastern New England Section is host, and other participating Sections are Connecticut, Pioneer Massachusetts, and Western New England.

Topic for the Conference is "Plastics for Electronics," and the all-day sessions will be held at Lowell Technological Institute, Lowell, Mass. The symposium should be of particular interest to plastics manufacturers, all members of the electronic industry, and manufacturers of electronic components.

Papers will be presented on the following subjects: Dielectric Insulation; Potting, Encapsulating, and Impregnating Fluorocarbons in Electronics; Housings for Electronic Equipment and Components, Reinforced Plastics for Radomes and Reflectors; Silicones in Electronics; Plastics for Printed Circuits; Artificial Dielectrics; Conductive Plastics for Electronics, and Plastic Specifications for Electronics.

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News of the Industry

Monsanto-St. Regis Promotion

Production and marketing of a foamed styrene-paper sandwich material have been undertaken jointly by Monsanto Chemical Co., Springfield, Mass., and St. Regis Paper Co., New York, N. Y., Known as Foam-core Board, the product consists basically of a stiff, foamed-styrene core with a sheet of specification kraft paper on either side. Made in a continuous operation, the sandwich retains high compression strength under conditions of severe humidity.

The move affords Monsanto an opportunity to develop materials and markets in the field of foamed plastics; St. Regis, in the paper and container fields. The latter firm already has begun limited production of a container made from the board. Light-weight, the container keeps shipping charges low while retaining sufficient strength to withstand long-distance shipping under the high-humidity conditions of refrigerator cars and trucks. It is expected to replace the more expensive wood and fiber-board containers which are presently being used.

Three-Firm Working Agreement

A third firm, Regal Plastic Co. of Kansas City, Mo., has joined the working arrangement already established between Durable Formed Products, Inc., New York City, and Speck Plastics, Inc., Port Washington, N. Y. The three firms will have no direct or indirect integration with each other, but will coordinate technical know-how, production facilities, sales service, product development design facilities, and research programs.

The coordinated program is applicable to the precision forming and fabricating of thermoplastic sheeting, low-pressure forming of pre-impregnated Fiberglas mat and cloth, matched-metal molding of glass-reinforced polyesters, and thin-gage vacuum drawing. The companies will be able to offer a combined manufacturing space of 70,000 square feet, plus the use of 42 pneumatic forming presses.

Forms Plastics Coating Firm

Formation of a plastics coating firm, Polykote, Inc., with plant and offices at 877 Addison Road, Cleveland, O., has been announced by James R. Jones, Jr., and the firm of R. W. Renton & Co. Mr. Jones, formerly of Ferro Corp., and Claremont Pigment Dispersion Corp., will serve as president. Associated with him are Robert Renton, president of R. W. Renton, and K. M. Keller, president of Keller Products, Inc.

The new company was formed through the purchase of R. W. Renton's coating facilities with the intention of expanding them in the industrial protective-coating field. The new service will offer hot- and cold-dip plastisols, vinyl sheet linings, epoxy, urethane, and neoprene coatings. Polykote already has been named district representative of Amercoat Corp.'s Amer-Plate vinyl sheet-lining materials.

Organizes Plastics Firm

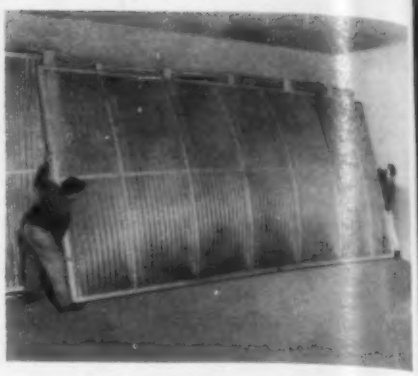
G. S. Plastics Co., with plant and offices at 15583 Brookpark Road, Cleveland, O., has become the newest member of a group of associated firms including General Supply Co., G. S. Equipment Co., and Singleton Co.; all serving the chemical processing, electroplating, and manufacturing industries. William A. Munkacsy, former president of Munray Products and Poly-Cyclo Products, will serve as president of the new firm.

G. S. Plastics' plant has complete, modern equipment for coating unusually large units, and has facilities for both custom formulating and production. The three major services offered to industry are a custom service of vinyl, epoxy, and neoprene coatings; manufacture of these coatings for resale in any quantity; and the manufacture of completed and coated equipment. In addition, the company plans to develop completely-new products and applications.

Announces Construction Plans

Plans for a single-story building to house its structural plastics department have been revealed by Aerojet-General Corp., Azusa, Calif. The unit will measure 140 by 200 feet for a total of 28,000 square feet. Construction methods to be employed will permit its doubling in size with little extra expense.

Contract for the new facility has been awarded to Dilworth Construction Co., also of Azusa. Aerojet-General is a subsidiary of General Tire & Rubber Corp.



Reinforced-plastic skylight is large, but light.

Reinforced Plastic Skylights

The largest, single job of custom-made reinforced plastic skylights has been completed by Marco Co., East Orange, N. J., for installation at the Barrington, N. J., factory of Owens-Corning Fiberglas Corp. The order consisted of 126 prefabricated and preassembled Marcolite skylights, each measuring nine by 20 ft.

Extruded-aluminum channel-truss members were heli-arc welded to a perimeter frame creating a wing-type structure for the panels. Preformed fibrous glass-reinforced polyester sheets, corrugated and curved to a 12-foot radius, were joined both mechanically and with mastic to form a one-piece panel to set over the aluminum frame. An extruded aluminum retaining member was applied to hold the panel in place.

In spite of their size, the preassembled units weigh but 282 pounds. The skylights were crated and shipped to the plant site in specially-extended trailer trucks, 10 at a time. At the job-site they were hoisted to the roof, placed on prepared curbs, and fastened in a simple operation.

Urethane Foam Insulation

"More than a million square yards of urethane foam will be used during 1957 as interlining for outerwear garments," according to Peter Oppenheimer, Brand & Oppenheimer, Inc., New York, N. Y., "and upwards of 15-million square yards of the material will be put to this purpose annually, sometime within the next three years." Appearing at a demonstration co-sponsored by his firm and Mobay Chemical Co., Mr. Oppenheimer pointed out, "Chemical foam has already proved its ability as an insulating material, and that trade sources which have tested it in clothing applications are enthusiastic about its potential."

"Urethane foam interlining provides as much warmth as any insulating material on the market; at the same time being lighter in weight, easier to clean, and longer lasting. Garments can be made lighter and less bulky without sacrificing warmth retention, thus affording greater freedom of action and comfort," Mr. Oppenheimer added.

Brand & Oppenheimer markets the foam under the tradename Fahrenheit. Such

firms as White Stag-Bantamac, Sears Roebuck & Co., and J. C. Penny already have ordered urethane-lined garments for the fall and winter seasons.

Popular Plastics Expands

The public offering of 15,000 shares of Popular Plastic Products Corp.'s common stock has been over-subscribed, according to Leonard E. Elterman, president of the injection molding firm. Increased business and expansion into other related fields reportedly were responsible for the change to a publically-owned corporation.

The most recent expansion involved the formation of Popular Fibreglass Products Corp., to engage in the reinforced plastics field. Located in Northport and East Northport, L. I., N. Y., the subsidiary will produce both custom and proprietary products. Howard E. Greene, former chief engineer of Imperial Fibreglass Industries, will serve as general manager.

Another recently-formed subsidiary, Dewl Plasti-Toy Corp., has brought out a new line of toys covering every phase of the toy industry. This firm's first introduction was the Link-It construction set, which met with considerable success.

Improves Battery Capacities

Porous polyethylene tubing encases the Silvium grid spines and active material on the positive plates in the new TG Exide-Ironclad Giant battery. Permeable to the diffusion of electrolyte and passage of current, the tubing prevents practically any loss or shedding of active material. This enables the Exide Industrial division of Electric Storage Battery Co., to establish new capacity standards at practically no increase in space and weight.

Toy Evaluation Honor Roll

A non-profit organization has been formed to provide a sampling method for predetermining the public acceptance of a given toy. Called the Toy Evaluation Honor Roll, the group will use a rotating panel of millions of children. This panel will be broken down into age groups of 3-12 years, sex, and geographical location.

Children's names will be obtained through a letter-writing contest and other methods. Each month, sample toys will be sent to a selected group of panelists, along with a questionnaire. The children, or their parents, will be asked to evaluate the toys as to durability, play value, general merit, and appeal.

The administrative panel is made up of educational and child-psychology experts, with several prominent members of the

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toy industry as consultants. Toy manufacturers will be invited to submit samples prior to general distribution.

Lithium Institute Launched

The recently-formed American Lithium Institute has initiated a program of sponsored research on lithium alloys at Massachusetts Institute of Technology and Pennsylvania State University. Fellowships will be established at the two schools. Founder companies of the Institute are American Potash & Chemical Corp., Foote Mineral Co., and Lithium Corp. of America.

Lithium is not used widely in the plastics field; however, investigations show lithium dispersions to be effective catalysts in polymerization reactions. They are used also to catalyze the polymerization of isoprene to a truly "synthetic-natural" rubber.

Schedules Kralastic Plant

Foundations have already been laid for a new chemical plant near Baton Rouge, La., according to George A. Vila, vice president and general manager of U. S. Rubber's Naugatuck Chemical division. Scheduled for a December opening, the plant will require a total investment of more than $7-million. The facility is expected to triple Naugatuck's production of Kralastic, a styrene copolymer used in the manufacture of pipe, automotive parts, and many other industrial items.

The new plant will include production, laboratory, and office units. Styrene, butadiene, and acrylonitrile will be shipped from the nearby area by tank car and truck. J. Scott Brown, factory manager of the present Baton Rouge plant, will manage the new unit as well.

Zenith Plastics Test Facility

Construction is well under way on the electronic testing facilities being built by Zenith Plastics Co. in Gardena, Calif. A wholly-owned subsidiary of Minnesota Mining & Mfg. Co., Zenith is concerned primarily with the production of reinforced plastic parts for military aircraft.

More than $200,000 is being spent to construct the four-story test center, plus a number of testing towers. An additional $100,000 will be used to purchase equipment. Scheduled for completion by early summer, the facilities will be used to test radomes. These reinforced-plastic radar housings are a critical factor in determining the ultimate effectiveness of search navigation, and gun-laying radar equipment. For this reason, they must conform to extremely high standards of dielectric performance.

Acrylic glazing eliminates breakage of cab drop-windows.

Acrylic Glazing Cuts Costs

The Pennsylvania Railroad saved an estimated $3,500 last year through the use of acrylic glazing. Installation of a ⅛-inch thick Plexiglas sheet as the drop side-window in the motorman's cab has virtually eliminated replacement costs. The two- by 2½-foot glass window formerly used had been especially vulnerable to breakage.

The motorman lowers the window into a 30-inch pocket for opening and sash impact invariably shattered the pane if special care was not exercised. At the Paoli, Pa., car shop, it is estimated that the breakage rate for the glass windows approximated 100% annually. In addition to replacement, a secondary cost involved compensation for personal injury claims arising from broken glass.

In addition to money savings, the acrylic glazing affords greater safety to the motorman. Its lighter weight makes lowering and raising the window an easier task, and the resiliency of the material enables it to accommodate bending, distortion, and warping of the sash.

Plexiglas is supplied by Rohm & Haas Co., in large sheets which are cut to size with a bandsaw. The panes are slightly undersized, to allow for expansion with temperature change. A semi-soft sealing compound is placed along the edge of the pane and folded down on each side to form a channel. Beading is put into place after the pane and sealer have been installed in the sash. The panes are washed every third day with a solution of oxalic acid in water.

Cabot To Erect Pigment Plant

Cabot Carbon Co., a subsidiary of Godfrey L. Cabot, Inc., has purchased a 75-acre tract near Tuscola, Ill., and plans the immediate construction of a Cab-O-Sil plant. This material, a silicon oxide pigment will be produced by the vapor-phase hydrolysis of silicon tetrachloride in a hot gaseous environment.

Hydrogen will be supplied by U. S. Industrial Chemical Co. from its adjoining plant. USI's subsidiary, National Petro-Chemical Corp., also has a plant in the vicinity, and will absorb Cabot's hydrogen chloride production. This acid is a by product of Cab-O-Sil manufacture.

Degussa, of Germany, has been supplying Cabot with the pigment, but the demand has grown to the point where an American plant is vital. Cab-O-Sil is said to surpass precipitated, synthetic silicas with respect to over-all properties.

When completed, the new plant will have a capacity of about 100 carloads per year, and will employ 50 people. The material is used as a reinforcing agent for rubbers, as a filler for plastics, as a suspending and flattening agent for paints and varnishes, as a jelling agent for lubricants, and as an anti-slip agent in waxes.

Reinforced-Plastics Standards

Standards for reinforced-plastic plumbing fixtures used with bathtubs, laundry tubs, shower receptors, sinks, and water softener tanks are being set up by the Reinforced Plastics Plumbing Fixtures Standards Committee of SPI's Reinforced Plastics Division. These standards will cover the plastics raw materials, resistances of the fillers to stain and chemical attack, methods of manufacture, structural qualities, washability, weatherability, gloss retention, fungus and vermin resistance, and inspection and test methods.

When agreed upon by the SPI committee, the standards will be submitted to the Department of Commerce's National Bureau of Standards. The ultimate objective is to have them promulgated by the Department of Commerce as official commodity standards. Acceptance will permit their use by such groups as Plumbing and Building Code officials, the Veterans Administration, and the Federal Housing Administration.

Alpha Completes Pipe Plant

A new plant devoted to the production of PVC pipe and tubing has been completed by Alpha Plastics, Inc., Livingston, N. J. A pioneer in the production of the corrosion-resistant piping, Alpha now has more than 12,000 square feet of production and office space.

Plastics have been used extensively throughout the facility: corrugated, fibrous glass-reinforced polyester partitions; plastic window blinds, affording both light and privacy; and reinforced plastic furniture.

Alpha's new PVC plant and office building.

The firm presently offers normal- and high-impact pipe in nominal sizes ranging of ½-4 inches, and in lengths of 10 and 20 feet. Valves and fittings also are available.

Announces Construction Plans

Plans for constructing a vinyl chloride monomer plant that will have an annual production of 50-million pounds have been announced by Diamond Alkali Co. Scheduled for completion early next year, the facility will be located at Diamond's Deer Park plant in Houston, Tex.

Scientific Design Co., Inc., will design and engineer the new unit, and Brown & Root, Inc., will do the actual building. In addition to vinyl monomers, the plant will produce acetylene from natural gas.

Integrate Sales Forces

Garlock Packing Co., Palmyra, N. Y., and it subsididary, United States Gasket Co., Camden, N. J., have integrated their sales forces. Production facilities of the two firms were integrated in August 1955.

The unified sales force will operate out of Garlock's 30 offices and warehouses, which are located throughout the United States and Canada. The move is expected to simplify purchasing problems by offering a single source of supply and service. United States Gasket Co. now will be known as the plastics division of Garlock.

Opens Polymer Research Lab

The main offices and laboratories of W. R. Grace & Co.'s polymer chemicals division were opened officially on March 7. Located in Clifton, N. J., the one-story brick facility covers 50,000 square feet of space. It houses general offices, research and development laboratories, machinery for development of plastics applications, and laboratories for applied physical, chemical and electrical evaluations.

The principal material undergoing tests at the new lab is Grex, the firm's high-density (linear) polyethylene. Grace service engineers are developing new techniques for molding and extruding the material. The polymer chemicals division was organized approximately one year ago as the seventh chemical division of W. R. Grace & Co. Other divisions include Dewy & Almy, Dewy & Almy Overseas, Davison Chemical, Cryovac, Grace Chemical, and Grace Research & Development division.

Grace's new office and polymer lab.

Opens Radiation Facility

What is reported to be world's largest radiation machine manufacturing and test facility was opened on March 3 by High Voltage Engineering Corp. Located in Burlington, Mass., the plant covers 88,000 square feet of floor space and cost $2-million.

The plant contains enough radiation test vaults to allow simultaneous operation of 16 atom smashers. Vault lay-out is varied to provide for testing of both Van de Graaff particle accelerators and the firm's microwave linear accelerators. Maximum radiation protection is provided by the four-foot thick walls and the 20-ton concrete block door. Nine-foot mounds of earth are piled against the exterior of the building where the vaults are located.

Interior view of High Voltage Engineering Corp.'s new plant in Burlington, Mass.

About 50% of the building's floor space is given over to production, and the remainder is divided into testing, engineering, and research laboratories; executive and administrative offices; chemical and electronic laboratories; and darkroom, and other service departments. Special equipment includes a monorail system running throughout the machine shop, a stock room, and a paint booth.

Insulated aluminum skin panels dominate the exterior facade. The area adjacent to the building entrance is faced with brick veneer. Flooring is principally concrete and vinyl tile, and the floors in the machine shop, sheet-metals department, and model shop are of wood blocks. A 59-foot tower will be used for testing large, vertical accelerators.

Color Affects Melamine Sales

Color is the most important single factor in the sale of quality melamine dinnerware, in the opinion of 108 chinaware, houseware, and hardware buyers surveyed by the recently-extablished Melamine Council. Other categories open for choice in the survey were shape, decoration, durability, package, price, weight, advertising, and "any others."

Replies indicated that 25.8% of the buyers regard color as the dominant factor in sales stimulation. Price, shape, and durability were grouped around 18%, and decoration received 12% of the votes. Weight and packaging were considered to be of negligible influence.

In Brief . . .

Monsanto Chemical Co., St. Louis, Mo., has scheduled an advanced management course for managerial-level employes, patterned along the lines of a university seminar. The course will be held early this year at Excelsior Springs, Mo.

A. Schulman, Inc., Akron, O., worldwide dealer in plastics and rubber, has established an office at 1127 Wilshire Blvd., Los Angeles, Calif. Frank M. Francis will head the West Coast operation.

Archer-Daniels-Midland Co., Minneapolis, Minn., has purchased an interest in Scado Kunstharsindustrie, N V, Zwolle, Netherlands. One of that country's leading manufacturers of resins and plasticizers, the firm will now be known as Scado-Archer-Daniels, N V. Formulas and technical know-how will be exchanged.

Eastman Chemical Products, Inc., New York, N. Y., has announced that all Tenite polyethylene pipe will bear yellow and white tags informing purchasers about the material. In addition to setting forth the advantages and uses for the pipe, the tags will explain installation procedures. Space will be provided for the extruder's imprint.

Reinforced Plastics

(*Cont'd. from page 393*)

to reinforced plastics after they have heard of so many failures. This hampers the growth of the industry in general. The low-bidder contributes to keeping quality standards low. Unsatisfactory products also reflect on the industry, and prevent many good products from being manufactured from reinforced plastics.

Therefore, the reinforced plastics molder who deliberately underbids to get the contract hurts many people in addition to himself. His idea of "prestige" is a confused one. Any project done well is a "prestige" job. Why can't prestige jobs also be profitable ones?

In the next column, I will discuss the problems involved in under-estimating and how to avoid them by presenting specific examples on "invisible" expenses; how to be more careful; and how to set up check points to guide the estimator.

—The End

News from Abroad

New Polycarbonate Plastics

In a paper read September 22, 1956 before a meeting of the Association of German Chemists in Hamburg, Germany, H. Schnell, for the first time reported in detail the results of investigation on a new type of thermoplastics, the polycarbonates, carried out at the Uerdingen Works of Farbenfabriken Bayer A.G. Research had centered on the development of a useful method of producing high molecular materials from polyesters of carbonic acid. The starting materials were 4,4'-dioxydiphenyl alkanes, of which about 30 different compounds were known or produced. When these alkanes are dissolved in a dilute sodium hydroxide and phosgene passed through at 20-30° C., solid polycarbonates are formed, the molecular weight of which can be regulated.

Practically all the polycarbonates developed so far are soluble in methyl chloride; some also in aromatic hydrocarbons, esters, and ketones. In the absence of water vapor and alkaline or acid impurities, they are stable for prolonged periods up to 300° C., in a molten state. From the polycarbonate solutions, fibers, films, and finishing coats can be prepared by the usual methods. Fibers and films, as well as blown film, blown objects, and injection and compression moldings, can be made from the melt, employing customary processes and equipment. Aqueous emulsions are prepared from concentrated solutions.

The polycarbonates do not have sharp melting points, but pass from the solid to the fluid state in a melting range that may be from 10-20° C.; the melting zone lies between 150-300° C. with some types. Water absorption of dry films, stored at 95% relative humidity up to weight constancy, is between 0.1-0.3%, as compared with 0.05% for a similar polyethylene film, and 4.2% for one of cellulose acetate. Gas permeability is very low. In aging tests over several years, foils and injection-molded parts from different polycarbonates showed neither discoloration nor changes in physical properties; they were essentially unchanged after storage for eight weeks at 170° C.

A polycarbonate produced from 4,4'-dioxyl-diphenyl-2,2-propane was practically unaltered after four weeks' treatment with boiling water. This particular product resists water, neutral salt solutions, aqueous mineral acids up to high concentrations; hydrofluoric and nitric acids, strong oxidizing agents, weak alkalis (they have limited resistance to sodium and potassium hydroxides, and are not stable to ammonia and amines); aliphatic hydrocarbons, higher alcohols, synthetic and vegetable oils and fats, and fruit acids. Methanol has a swelling effect, and causes brittleness at high temperatures; most other organic solvents have a swelling effect.

The physical properties of polycarbonate films are shown below.

The physical properties of injection moldings from a melt of a polycarbonate made from 4,4'-dioxy-diphenyl-2,2 propane can be compared with those of Durethan BK, and Cellidor AH, a polyamide and cellulose acetate, respectively, as follows.

The dielectric values for film cast from solutions of polycarbonates are as follows: dielectric strength, 100-120 kV/mm.; loss angle, 10.10^{-4}; dielectric constant, 2.6; and surface resistance, 19.10^{13} ohm—cm. at 80% relative humidity. The loss angle and dielectric constant values remain practically constant up to 150° C.

Method of Production	State of Orientation	Tear Strength, Kg/Cm²	Elongation at Rupture, %	Fold Endurance (No. of Folds)
Cast from solution	Unstretched	820	180	>10,000
" " "	Stretched 200%	1,400-1,700	32-40	>10,000
Blown film	No added stretching	890	155	>10,000

	Polycarbonate	Durethan BK	Cellidor AH
Bending strength, kg./sq.cm.	800-1,000	740	1,500
Impact bending strength, cm.kg./sq.cm.	100% Unbroken	100% Unbroken	12
Impact strength, notched, cm.kg./sq.cm.	9-10	15	10
Hardness (ball) test (60 sec.) kg./sq.cm.	900	800	1,100
E modulus, kg./sq.cm.	22,000	12,400	22,000
Dimensional stability in heat (Martens), °C.	Approx. 125	53	63
Heat resistance in service, °C	Approx. 140	Approx. 120	—

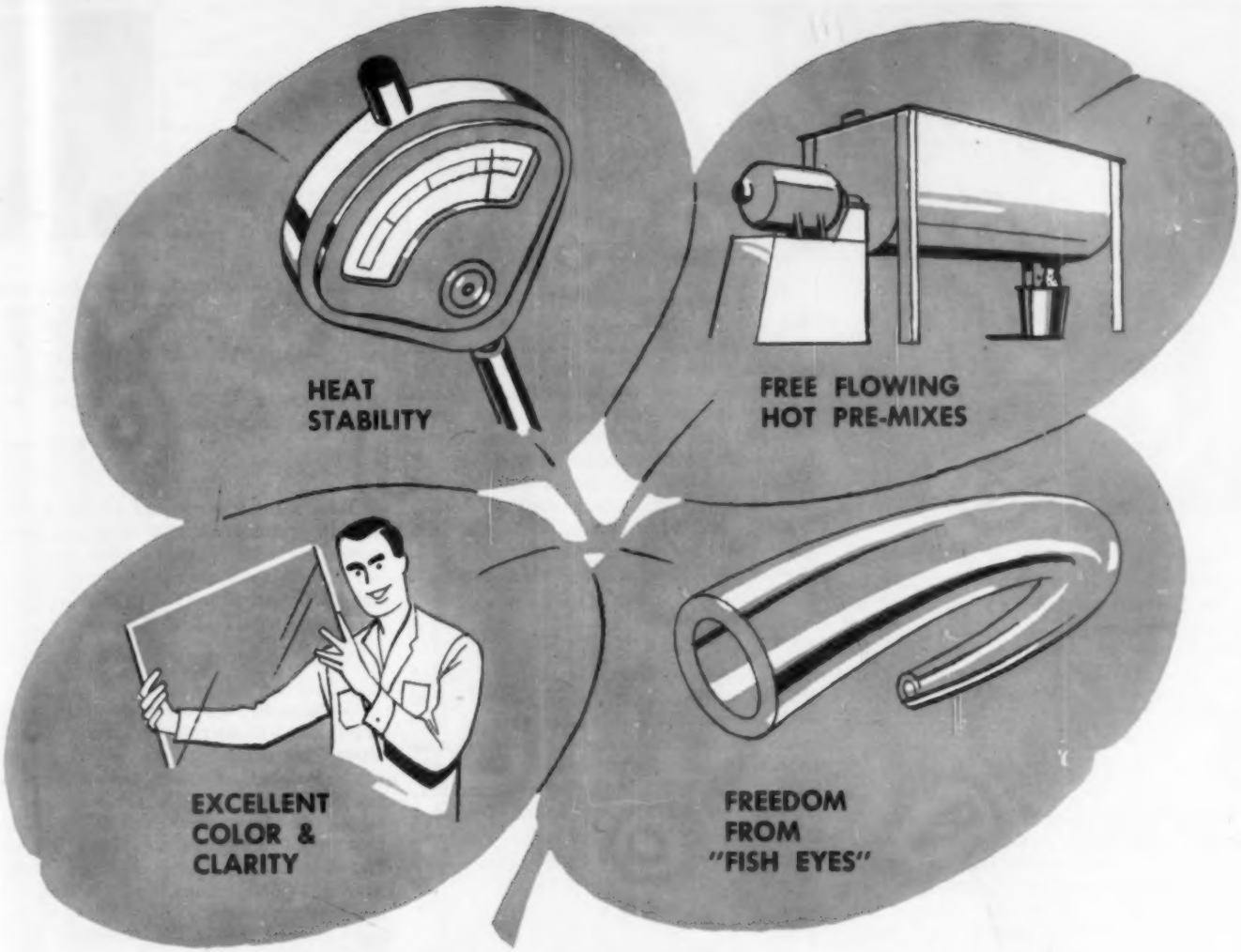
Developments in Japan

Important new developments in Japan's rapidly-growing plastics industry may be looked for in 1957, trade reports indicate. The Asahi-Dow Co. and the Monsanto-Kasei Co., which have agreements on technical cooperation with American Dow and Monsanto, respectively, are beginning to produce polystyrene from styrene monomer. Similar arrangements have been made by several Japanese firms for polyethylene, in which interest is so great that there seems to be some grounds for the fear of over-production expressed in certain quarters. Sumitomo Chemical Co., and Mitsuit Chemical Co. already apparently are producing this material, the former using the I.C.I. high-pressure method, and the latter the Ziegler Process. Other firms planning to take up polyethylene are Showa Denko (which has a technical arrangement with Philips Petroleum Co.), Furukawa Chemical Co., and Mitsubishi Petroleum Co.

There also is to be considerable expansion in the production of PVC and products of PVC. The Kureha Kasei Co. was scheduled to produce 550,000 pounds of PVC monthly at its Nishiki plant by the end of 1956, using hydrochloric acid gas conveyed by pipe-line from the nearby sister plant of Kureha Chemical Co., and acetylene from its generator. Shinitsu Chemical Industry, a leading Japanese manufacturer of silicone resins, plans a monthly output of 1,320,000 pounds of PVC from acetylene derived from carbide and hydrochloric acid gas (by chlorinating methane and hydrolysis of chlorosilane), it is learned. Japanese Geon Co. has started operating its new PVC plant at Takaoka City. The Yokohama Rubber Co. is to double its present output of PVC film and sheet, as well as of rigid PVC products.

Expansions in other fields also have been announced. Toyo Koatsu Co. has begun to produce polyester resins at the rate of 75 metric tons per month at its Ofuna plant; this is the fourth Japanese plant now making these resins. Japan Reichhold Chemical Co. is said to have increased output of urea and polyester resins at its Osaka plant, and to be considering the erection of a new plant in Tokyo. The Nihon Hikoku Co. has an arrangement with Elastomer Chemical Co. for the manufacture of vinyl sponge, and Nihon Bulka Co. will make Kel-F.

Several companies are preparing to meet the growing demand for polyethylene-laminated paper, and for polyethylene and polystyrene extruded sheets by installing additional machinery. Japan produces suitable machines for the purpose, but some are being imported. In fact, Japan produces a variety of machines for the plastics industry, including extruders and injection-molding machines. One Japanese company is said to be making 100-ounce injection molding machines. Before long, Reed-Prentice and Windsor machines also may be made in Japan. The Fujikashi Seiki Co. is understood to have applied to the government for approval of its proposed technical agreement with Reed-Prentice.



LOOKING OVER A 4 LEAF CLOVER

In seeking ways to improve your product, look at these four advantages offered by Escambia PVC 1250:

- Outstanding heat stability with its advantages in quality control.
- Free-flowing hot pre-mixes.
- Excellent color and clarity.
- Freedom from "Fish-Eyes."

Other new polyvinyl chloride resins include.

ESCAMBIA PVC 1225—intermediate molecular weight resin particularly adapted for supported and unsupported sheeting.

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ESCAMBIA CHEMICAL CORPORATION

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Names in the News

Pach Bros., N. Y.

George R. Vila

George R. Vila has been elected a vice president of United States Rubber Co., and will serve as general manager of its Naugatuck Chemical division, He replaces **John E. Caskey,** who is retiring after 42 years of service. Mr. Vila formerly served as assistant general manager of the division.

Frank W. Reinhart, chief of the plastics section, National Bureau of Standards has received the Meritorious Service Award of the Department of Commerce for "major contributions to the science and technology of plastics, and for highly-distinguished authorship."

George H. Callum has been appointed general sales manager of manufacturers' products in the footware and general products division of United States Rubber Co. **William J. Mulvey** succeeds him as sales manager of Naugahyde vinyl-coated fabrics.

J. Walter Whitacre, Jr., has been assigned to the Southeastern area as a field representative for L. O. F. Glass Fibers Co., and will work out of the Jacksonville, Fla., district. He previously served as salesman for R. W. Nichols Co., and was owner of Fort Meigs Machinery Co.

Frank E. Hadley, Midwest sales manager for Catalin Corp. of America, has been elected vice president in charge of sales for the thermoplastic division. He has been with Catalin for nearly 17 years, and has served in numerous sales capacities.

Karoly Herein has joined the research department of Monsanto Chemical Co.'s plastics division, Springfield, Mass.

Larry Green has joined Plastic Age Co., San Fernando, Calif., as plant manager of the transparent plastics and reinforced plastics divisions. He formerly served with Copolymer Corp. **David M. Ross,** chief of quality control, has been named assistant plant manager. **Jack Maloney,** former supervisor of the acrylic plastics section, becomes production supervisor. **Howard Young** has been named chief of quality control; **A. W. Knieriem** will head the tool engineering department, and **H. E. Renner** has been appointed sales manager.

Sumner L. Trilling has been appointed general sales manager of General Tire & Rubber Co.'s Bolta Products division, succeeding **Daniel E. Hogan, Jr.** Mr. Hogan is presently managing his own plastics-extruding firm in North Andover, Mass. Mr. Trilling has been with the firm for over 10 years, serving first as sales manager, and later as general manager of the institutional products division.

Frederick H. Dodkin

Frederick H. Dodkin has been named assistant to the general manager of General Tire & Rubber Co.'s Bolta Products division. He has been with Bolta since 1950 as controller, and will retain this position in addition to new duties.

William Fondiller has been appointed technical consultant and special representative for Mycalex Corp. of America, with particular emphasis on insulating materials for the communications industries. He had retired as assistant vice president of Bell Telephone Laboratories in 1951.

Charles F. Radley has retired from active duty with Oakite Products, Inc., after 40 years of service. He was director of publicity for the past 30 years, and handled the firm's industrial advertising program.

Leep Zelones

Jay C. Searer

Jay C. Searer has been appointed works manager for the Durez Plastics division of Hooker Electrochemical Co. Dr. Searer was formerly production manager of the division, and will continue to make his headquarters at the main plastics plant in North Tonawanda, N. Y.

John Kempf has joined Furane Plastics, Inc., as product development manager of adhesives and coatings. He previously served as associate director of research for U. S. Stoneware Corp., and as process engineer at de Haviland Aircraft Co.

Norman E. Alexander has been elected president and director of Sun Chemical Corp., Long Island City, N. Y. He succeeds **Ralph C. Persons,** who recently retired. Mr. Alexander is president and director of Ansbacher-Siegle Corp. Other new board members are **Ralph Stillman,** Grace National Bank; **Howard Vultee,** Marine Midland Bank & Trust Co.; **William Steinschneider,** Lotte Chemical Co., and **Joseph E. Harris,** Northern Pacific Television.

Harold K. Latourette has been appointed manager of organic research and development for the Becco Chemical division of Food Machinery & Chemical Corp. A F. M. C. employe since 1951, Dr. Latourette was previously a member of the central research laboratory staff.

Wayne F. Nelson has been appointed director of research and development for A. Schulman, Inc., Akron, O. He previously served as assistant plant manager, plant manager, and director of research for American Container Corp.

Rodman Photo Studio

William J. Monahan

William J. Monahan has been appointed plastic sales manager for Seamco Chemical Co., Holyoke, Mass., a recent entrant into the field of polystyrene production. He formerly served with Dow Chemical.

Names in the News (Cont'd.)

E. W. Vaill has been appointed as a technical service engineer for Bakelite Co's molding materials division, and will maintain headquarters in New York City. He joined Bakelite in 1932, and has served as a molding materials technical representative in the New England area for over 20 years.

Leverett A. Anderson has been appointed sales representative for Whittaker, Clark & Daniels, Inc., in the Ohio area.

James P. Okie

James P. Okie has been appointed assistant general manager of Diamond Alkali Co's plastics division, Cleveland, O. A 24-year veteran in the petroleum refining and chemical processing industries, Mr. Okie most recently served as manager of economic evaluation for Olin Mathieson Chemical Corp.

Paul N. Leech has been appointed sales representative for Emery Industries, Inc., in the Mid-Atlantic area. Prior to joining Emery, Mr. Leech sold for M & R Dietetic Laboratories.

Richard Jarzombek has been named chief chemist of Logo Inc.'s coatings laboratory. He will be responsible for the formulation of special finishes, sales service, evaluation, and testing.

Elmer F. Schumacher, general director of sales for Du Pont's polychemicals department, has retired after 48 years of service. He had held his most recent office since 1950, and plans to continue residence in Wilmington, Del.

Charles W. Manly

Charles W. Manly has been appointed director of sales and service engineering for Modern Plastics, custom designers and fabricators of plastic materials in Miami, Fla. Mr. Manly has over 21 years experience in various engineering capacities.

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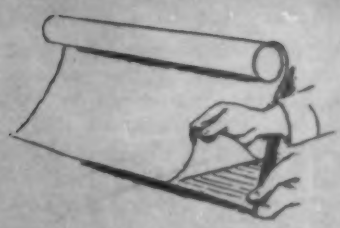
RELEASE PROBLEMS . . .

Patapar® Releasing Parchments

As a tray liner for molding polyurethane foams, Patapar releases easily — does not pit the surface of the foam.

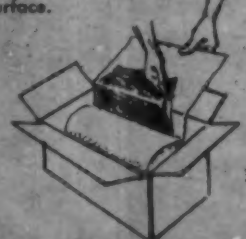


Patapar is the ideal protective backing for pressure sensitive plastics — can be attractively printed for product identification.

In the manufacture of polyester Fiberglas sheets, Patapar provides an efficient release backing. Imparts satin-like finish.

Patapar performs perfectly as a separator for rubber tape. Also used as a core cover.

Ideal as a protective release backing for pressure sensitive surfaces. Fiber-free, Patapar will not form a fuzz on the protected surface.



Effective separator for uncured, natural or synthetic rubbers. Imparts a smooth surface. Resists adhesion build up.

Patapar Releasing Parchments have dense, fiber-free texture – high resistance to penetration or migration of oil and softeners – permanent releasing action. They are totally inert to any surfaces they contact.

They show excellent performance in many processes involving: *synthetic rubbers, polyurethane foams, polyesters, vinyls, organic adhesives, organosols, phenolics, acrylics.*

A brochure of testing samples and detailed information is available on request. If desired we will give technical assistance on your releasing problems. Write us on your business letterhead.

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Sales Offices: New York, Chicago
West Coast Plant: Sunnyvale, California

HEADQUARTERS FOR VEGETABLE PARCHMENT SINCE 1885

New Materials

Write item numbers on Reader's Service Card to obtain more information.

Filled-Epoxy Casting Resin

A lead-filled epoxy resin, developed to serve as a shield against radioactive sources, has been introduced by Furane Plastics, Inc. Called Epocast 11C, the resin's high density makes it a good ballast material in boat hulls. As a casting resin, it faithfully reproduces all shapes and configurations.

Mixing proportions call for 100 parts by weight of Epocast 11C to 1.5 parts by weight of Hardener 988. The mixture cures overnight at room temperature into a hard, stable mass. Complicated shapes such as shields about valve bodies, pipe fittings, and the most intricate shapes currently used in nuclear power plants offer no problem.

Following are property data for the resin in both the cured and uncured states:

Pot Life, min.	60
Density, gms./cc.	6.5
Flexural strength, room temperature, psi.	5,700
At 150°F., psi.	4,500
Compressive strength, room temperature, psi.	10,000
Hardness Store "D"	77
Viscosity, cps.	78,000

Readers' Service Item M-1

Organosol Coating for Metals

An organosol formulation, based on Pliovic AO vinyl dispersion resin, has been developed by the plastics department of Goodyear Tire & Rubber Co.'s chemical division for use in decorative and protective coatings on metal surfaces. Formulated with about 35 parts of plasticizer per 100 parts of resin, the coating incorporates chemically-stable pigments.

Unlike plastisols, which generally are dip-coated due to their high viscosities, organosols can be diluted with mineral spirits and di-isobutyl ketone to optimum sprayable viscosity. The diluting solvents must be mixed before addition, since a localized concentration of mineral spirits may cause flocculation of the resin. Dilution with a volatile organic liquid makes possible a wide range of compound viscosities, while simultaneously holding the plasticizer concentration to a minimum. Harder, tougher films with improved adhesion are obtained.

Sufficient adhesion of the compound to metal is not attained usually without an adhesive primer such as 2386-X Denflex. This material must be air- or force-dried for 1-2 minutes at 230-240° F. Care must be taken to prevent a heavy build-up of organosol during the spraying operation in order to prevent sag. If thinned properly, the coating displays a slight ripple which flows out to a smooth surface.

After spraying, the coating should be dried for three minutes at 230-240° F. This should be followed by a five-minute fusing period at 350° F. This schedule is appropriate for a two-mil coating. For heavier coats, a second application should follow after the first has been allowed to cool.

Readers' Service Item M-2

Non-Toxic Release Agents

Three controlled-viscosity release agents for rubber and plastic molding and the die casting of aluminum and zinc alloys, have been introduced by National Aluminate Corp. Odorless, smokeless, non-corrosive, and non-toxic, the materials are white in color and have flash points of approximately 175° F.

These Nalco release agents are organic materials of high molecular weight. A non-aqueous solvent serves as the dispersion medium. The specific gravity value for all three agents is approximately 0.8. RA-1 is a thixotropic grade; solid at rest, and fluid upon agitation. RA-2 is of medium viscosity, and RA-3 is thin and very fluid. The RA Series may be applied by brush, spray, or automatic injection techniques.

Readers' Service Item M-3

Phenolic Molding Compounds

Specifications for Resinox 2200 Black, a phenolic molding compound formulated specifically for heavy-duty electrical control parts and wiring devices, have been released by Monsanto Chemical Co.'s plastics division. The material is said to combine excellent dimensional stability with high arc resistance and impact strength. Other features include improved heat resistance, moldability, finish, and adaptability to automatic molding.

Physical and molded properties are reported as follows:

Particle size	6-Mesh
Density, gms./cc	0.7-0.8
Bulk factor	2.1-2.4
Pourability	Fair
Specific gravity	1.7
Flexural strength, psi	10,000
Tensile strength, psi	5,500
Impact strength, ft.lbs./in.	0.4
Arc resistance, sec	1.5
Water absorption, %	0.2
Shrinkage, in./in.	0.002-0.004

Readers' Service Item M-4

Corrosion-Resistant Greases

Three acid- and alkali-resistant greases for problem applications in the food, chemical, plastics, rubber, paper, and metal-working fields have been introduced by Keystone Lubricating Co. Known as the Keystone 5P line, the lubricants are available in four consistencies: heavy, medium, light, and extra light. All three greases have a smooth, non-fibrous body, and are pale amber to light cream in color.

These specialized lubricants are said to provide effective protection against more than 100 corrosive agents and solvents. They prevent leakage, preserve packings, protect equipment and floors, and lower operating and maintenance costs. Among their specific applications are lubrication of plain and anti-friction bearings, driving chains, pump-packing, and plug valves.

No. 5P7 has an aluminum base. Its medium density formulation has an ASTM penetration of 250 and an operating range of 0-175° F. Bentone-based 5P8 has the same penetration in the medium density, plus an operating range of 20-350° F. Lithium-based 5P9 is lighter in color than the other two; has an ASTM penetration of 250 in the medium-density formulation; and operates from 0-225° F. Available packages include one- and seven-pound cans, 25-pound pails, 100-pound kegs, and 400-pound drums.

Readers' Service Item M-5

Plastics Cleaner & Polisher

An anti-static powder for cleaning and polishing plastic and metal surfaces has been introduced by Schwartz Chemical Co., Inc. Called Rez-N-Polish, the dark brown powder contains an abrasive so fine that it can remove minor surface scratches without affecting the actual finish.

Rez-N-Polish was developed primarily to clean plastic windows, specifically the windshields on aircraft and boats. The material is sprinkled on a damp cloth and rubbed briskly onto the plastic window. A damp polishing wheel should be used to remove deep scratches.

Non-flammable and non-toxic, the cleaner can be used with acrylics, polystyrene, acetate, and with rigid and flexible vinyls. It is packaged in eight-ounce shaker-top cans, one- and six-pound cans, and 25- and 200-pound kegs.

Readers' Service Item M-6

Methacrylate Monomer

Dimethylaminoethyl methacrylate monomer, supplied with 0.25% N,N'-diphenyl-p-phenylene diamine as an inhibitor, is presently available from Rohm & Haas Co. The material may be polymerized with an azo-type catalyst such as azo-isobutyronitrile, or by irradiation with ultra-violet light. It also can be polymerized in aqueous solution with peroxide catalysts, provided the amine group is neutralized first with an acid to give a water-soluble salt.

Copolymers with methacrylate esters and acrylonitrile have been formed. Copolymerization with butadiene and vinyl acetate can be accomplished, provided the pH is maintained at seven or below. Typical properties are listed below:

Nitrogen content, %	8.9
Bromine number	12.4
Purity, %	99-99.5
Alkaline neutralization number	353
Saponification number	355
Boiling point, 760 mm., °C	180-190
Flash point, Tage ope cup, °F	165
Refractive index	1.4394
Hydrolysis pH, ca	8.5

Readers' Service Item M-7

New Thermoplastic Composition

A thermoplastic polycarbonate resin has been developed at the General Electric research laboratory in Schenectady, N. Y. Called Lexan, the material is said to offer a combination of toughness and heat stability never before available in a thermoplastic compound.

Parts made from Lexan are strong enough to withstand blows of a carpenter's hammer, a factor which enables G-E to predict that it will replace cast metals, ceramics, and other plastics in many applications. The polymer is being evaluated as a molding and extrusion compound, film, varnish, and coating.

Lexan is not yet available for field evaluation. Present limited quantities are being used in a controlled testing program which will determine its marketability. Early studies indicate that it can be made in a variety of transparent or opaque colors, with parts showing good surface hardness and gloss. Lexan film reportedly offers excellent electrical properties, high thermal stability, low water absorption, and high tensile strength.

Among the possible applications for the resin are coil forms, decorative and functional appliance parts, gears, automotive parts, housings, structural parts, handles, drawer rolls, electronic components, and telephone accessories. Properties are reported as follows:

Impact strength, notched Izod, ft.lb./in.	12-16
Unnotched, ft.lbs./in.	50
Tensile impact, ft.lbs./cu.in.	600-900
Tensile yield strength, psi.	8,000-9,000
Tensile strength, ultimate, psi.	9,000-10,500
Elongation, %	60-100
Flexural strength, psi.	11,000-13,000
Water absorption, 24 hrs., %	0.3
Indentation hardness, Rockwell "M"	70
Specific gravity	1.2
Arc resistance, sec.	100-140
Melting point, °F.	514
Heat distortion temp., °F., at 264 psi.	280-290
At 66 psi.	283-293
Volume resistivity, ohm-cm.	6×10^{15}
Dielectric strength (short time), ⅛-in. specimen, V/mil.	400
Dielectric constant, 60 cycles	2.8
At 10^6 cycles	2.85
Power factor, 60 cycles	0.009
Mold shrinkage, in./in.	0.005-0.007

Readers' Service Item M-8

VANSTAY Z

zinc bearing chelator for PVC resins imparts outstanding clarity, stability and resistance to sulfur staining when used as recommended with other VANSTAYS in many vinyl products.

Plastisols, Organosols, Extruded Goods

Use 1.5 VANSTAY R with .5 VANSTAY Z for maximum resistance to process heat and good service life.

Film, Sheeting, Molded Products

Use 1–1.5 VANSTAY HT with .5–1.5 VANSTAY Z to obtain the required protection.

When Roll plating is a problem:

Use 1.5 VANSTAY N with 1.5 VANSTAY Z as the stabilizing system.

Our Technical Service Representatives will gladly demonstrate the merits of our materials in your plant and assist in solving production problems.

Oliver

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New Equipment

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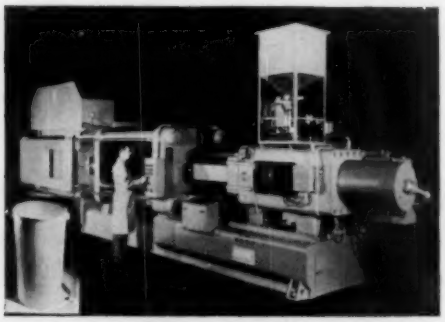


HPM 48/64-ounce injection molding machine accomodates such deep parts as the 20¼-inch polyethylene waste basket seen at the lower left.

Injection Molding Machine

An injection machine for molding extremely deep parts, such as the 20¼-inch polyethylene waste basket shown at the lower left corner of the accompanying photograph, has been designed and built by Hydraulic Press Mfg. Co. Designated the Model 800-H-48/64 Injection Molding Machine, the unit has four steel tie-rods and hydraulic mold clamp. Automatic feeding, weighing, and heating units are included.

Specifications are quoted as follows:

Shot capacity, oz.	48
Shot volume, cu. in.	81
Plasticizing capacity, lbs./hr.	300
Hopper capacity, lbs.	200
Ram spacer, in.	8
Pressure capacity, tons	800
Mold separating pressure, tons	52
Main ram diameter, in.	26
Booster ram diameter, in.	8.5
Platen size, in.	55 x 55
Maximum mold space, in.	36 x 55
Tie-rod clearance, in.	36.5 x 36.5
Mold thickness, min., without spacer, in.	20
With 8-in. spacer, in.	12
Ram travel, max., in.	35
Ram speed, closing, max., in./min.	525
Min., in./min.	57
Opening, max., in./min.	460
Min., in./Min.	42
Injection plunger pressure, psi	20,000
Plunger diameter, in.	5
Plunger stroke, in.	18
Rate of injection, max. cu.in./min.	2,300
Hydraulic pressure, psi.	3,000
Speed, rpm	1,800
Displacement, gms./min.	10.7
Floor space, ft.	28 x 6.5
Height, ft.	9
Weight, lbs.	87,000

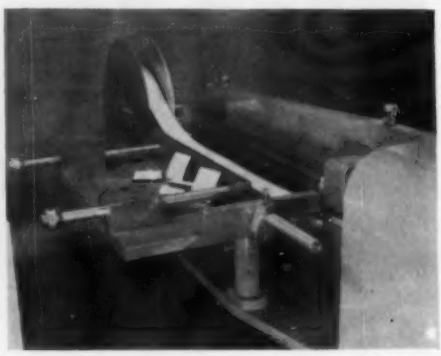
Low-pressure mold protection and a cycle open timer can be supplied as optional equipment. The unit is available with a higher injection plunger pressure, upon request.

Readers' Service Item E-1

Bench-Model Plastics Slitter

A machine for slitting or swatching plastic and rubber sheet has been introduced by Doven Machine & Engineering, Inc. Called the Bench Model Slitter No. R-18, the unit takes rolls up to 18 inches wide with any size core. Heavyweight, 0.04-inch plastic sheets can be accommodated.

Slits as narrow as 3/32-inch can be made, and the single-rewind principle permits rewinding with or without spacers. Fusing and interleaving does not occur. A cross-cut attachment eliminates

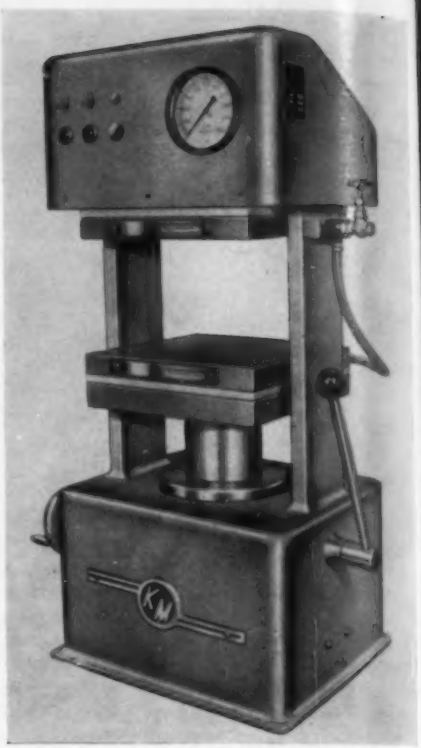


Doven bench-model slitter with cross-cut attachment in place.

the need for punch press equipment in swatching, and 10,000 swatches measuring one inch square by ¼-inch thick can be turned out in an hour.

Foot-switch operated, the slitter loads, threads, slits, and rewinds from the top. The circular knives require no sharpening, and are completely covered for safe operation. The motor has three speeds, and operates from any 110-volt AC socket. Over-all height is 20 inches, and table space required is 30 by 40 inches.

Readers' Service Item E-2



Model KM5-212 50-ton hydraulic press.

Two Large Hydraulic Presses

Thirty- and 50-ton models have been added to the hydraulic press line produced by Kingsbacher-Murphy Co. Their platens are made from a special semi-steel, and are precision ground. Cast-in heaters operated on 220 volts A. C., and temperature is controlled by individually-adjustable thermoswitches.

Water coils contained in the platens can be used to heat or cool them. The hydraulic system features a two-stage pump, which switches automatically from low to high pressure. Electrical components for the platens are mounted on a separate chassis inside the cabinet, and are accessible through a hinged door. The presses are compact units, delivered ready for immediate use.

Both models are available as standard presses with two or three platens measuring 12½ by 12½ inches or 12½ by 18½ inches; or as laminating presses with four platens, each measuring 12½ by 12½ inches or 12½ by 18½ inches. Specifications are reported as follows:

	30-ton presses	50-ton presses
Total platen pressure, lbs.	60,000	100,000
Piston stroke, in.	5	5
Platen opening, max. in.	9	9
With adapter, max. in.	5	5
Line pressure, max., psi.	3,050	5,000
Ram diameter, in.	5	5
Heating range, °F	200-600	200-600
Base depth, in.	16	16
Over-all depth, in.	24	24
Base width, in.	18	18
Over-all width, in.	22	22
Height, in.	42	42
Distance between uprights, in.	13.25	13.25

Readers' Service Item E-3

PROMISE...

in a squeeze bottle

Recently completed tests of PARAFLINT blended with polyethylene in squeeze bottles demonstrate the versatility of this new low cost synthetic wax. The PARAFLINT blends have an improved melt index, mix readily, flow better, and have improved moisture vapor resistance. These promising tests indicate that finished products will be firmer, glossier . . . look and feel better without any loss of impact or tensile strength. Molders of high or low pressure polyethylene will profit three ways – lower raw material costs . . . lower production costs . . . competitively superior products.

Available in quantity
Uniform quality
15¢ lb.
Carload lots

PARAFLINT

THE NEW SYNTHETIC WONDER WAX

For specific performance data write on your company letterhead for results of the squeeze bottle tests and our PARAFLINT "Fact File".

MOORE & MUNGER

33 RECTOR ST. NEW YORK 6, N. Y.

Plastics Hardness Tester

A precise instrument for measuring the resistance of plastics and plastic coatings to scratches, digs, and scrapes has been introduced by Taber Instrument Corp. Designated the Model 139-B Shear Hardness and Diamond Scratch Tester, the unit has a finely-balanced scale beam calibrated in grams to which is attached the Taber S-20 precision-ground contour shear tool.

The tool's cutting edge is lapped to a 25-millimeter radius with a 30° clearance, and is set at a 22° shear angle in relation to specimen motion. The tool cuts grooves up to 0.1-inch in width, depending upon the depth of the cut. Gradations on the scale beam are in 10-gram units, and the sliding weight provides an adjustment in load from 0-500 grams. An additional 500-gram weight can be attached to the end of the beam.

The scale beam is pivoted on ball bearings; its internal bore fitting over the shaft. The gage block can be raised or lowered to correspond with specimen thickness, thus maintaining the scale beam in level position at all times.

In actual operation, the scale-beam shaft mount is adjusted vertically to correspond with specimen thickness by loosening the thumb screw and inserting the specimen.

Taber Shear-Hardness & Diamond Scratch Testing Unit.

The movable mounting is brought against the specimen and locked in place. The tool is inserted in the scale beam, resting against a clear area of the specimen. After the weight is set, the specimen is turned slowly and steadily in a counter-clockwise direction to obtain the desired cut.

The diamond-scratch test measures the degree of surface resistance to scratching by a diamond point. The scale beam is designed to receive either the 139-55 or the 139-58 diamond tool. This test, like the shear-hardness test, must be performed under specified conditions of temperature, humidity, age of material, and other factors.

Readers' Service Item E-4

Slitter For Plastic Sheet

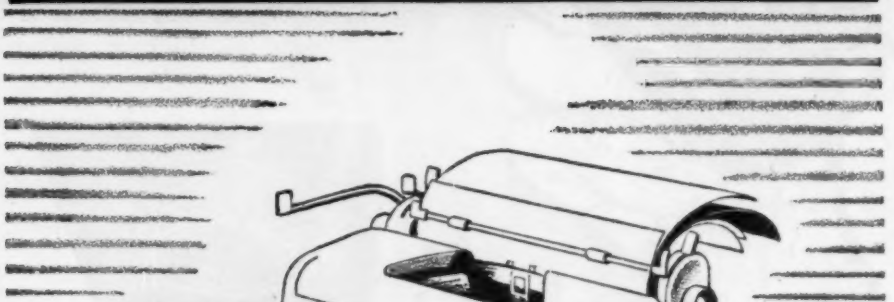
A slitting machine, designed to cut apart master sheets of plastic-packaged products without the need of expensive presses or dies, has been placed on the market by Abbott Plastic Machine Corp. Designated the Right-Angle Slitter, the unit is available in two sizes for 30- by 30-inch, and 40- by 40-inch master sheets.

Cuts can be made one inch apart, with a maximum of 30 cuts in each direction. Settings can be changed to any size within 15 minutes, and without tooling costs. The cutting heads allow for a three-inch clearance between the cardboard surface and the top of the product or blister. A guide located on the movable feed-table, properly locates the card in relation to the cutting blades.

The feed table is pushed until the cutters establish contact, and the card is cut in one direction. Tie points at 3-4 inch intervals hold the card until it is located and fed through the second set of slitters. Scrap is directed under the feed roller into a built-in bin. Finished parts are fed directly to a packaging table or conveyor.

Readers' Service Item E-5

"Colloid Corner" by COLUMBIAN



High Hiding Power makes the Message Clear!

When carbon paper receives the impact of the typewriter key, only a fantastically thin layer of wax-carbon dispersion is transferred to the copy paper. Yet this layer can provide the hiding power for clear, black reproduction . . . dramatic evidence of carbon black's ability to absorb the complete spectrum. Inks, paints and plastics are a few of the products which utilize this property of carbon black. Columbian Carbon Company can provide colloidal carbons with particle sizes from 9 to 90 millimicrons. These may have rough surfaces or smooth, high or low structure and controlled degrees of adsorption and absorption. All these qualities—and more—can be varied to custom-make a wide and useful variety of distinct colloidal carbons. Consult us about your application. Use our richness of experience—it is at your service. Or send now for our free technical booklet on properties of carbon blacks.

For Progress in Colloids

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COLUMBIAN Carbon Blacks are available in three forms: POWDER • BEADS • DISPERSIONS

New Products

Write item numbers on Readers' Service Card to obtain more information.

Spools of Teflon-insulated hook-up wire.

Fluorocarbon-Insulated Wire

Silver-plated copper hook-up wire, insulated with Du Pont's Teflon tetrafluoroethylene resin, now is available in sizes 16-28 from Haveg Industries, Inc. Controlled, 0.01-0.015 inch thicknesses of Teflon are extruded onto the wire, thus assuring a pinhole-free coating for full utilization of the material's excellent dielectric properties.

The hook-up wire meets National Aircraft standards and Government Specification MIL-W-16878-B. It can be supplied in any of 16 colors for coding purposes, or with spiral striping. Capable of continuous service at temperatures up to 260° C., the wire retains its toughness and flexibility down to —265° C. It is inert to all chemicals and solvents except molten alkali metals, and fluorine at elevated temperatures and pressures. The wire is expected to have wide usage in distribution and power transformers, as well as in aircraft, integral, and traction motors.

Readers' Service Item P-1

Polyethylene Slide-File Case

Another interesting application for polyethylene is the Opta-Vue 300 file case for 35mm color transparencies. Designed by Leotta & Parcher, Conshohocken, Pa., for Optics Mfg. Co., the case is both lightweight and durable. The case is injection-molded, as is the separately-molded handle band which interlocks in place.

All-polyethylene file case for film slides.

Among the design problems overcome in the Opta-Vue 300 are the elimination of overflexing through the use of a series of strengthening ribs and overlapped closure joints; the minimizing of sink holes through layout of interior partitions; and elimination of waxy appearance and feel through the use of a pebbled surface. Curving the front of the case provides for ease of carrying, and one-piece molding allows the use of an integral hinge.

Trim appearance of the unit is said to appeal to both men and women. Available colors are brown, blue, white, yellow, and coral.

Readers' Service Item P-2

Vinyl-Coated Acrylic Fabric

A tough, aircraft trim material made from vinyl-coated Dynel has been introduced by Sawyer-Tower, Inc. Dynel, Union Carbide's acrylic fiber, furnishes flame resistance, and the vinyl coating affords superior functional and decorative advantages in headliners, side panels, wainscoting, luggage-rack protectors, and insulation-blanket covers.

Lightweight and mildew-proof, the material may be scrubbed with soap and water. The trim is available in standard 44-inch width and a range of interior colors. Surface texture can be varied by treating the vinyl coating, and the composite can be obtained in plain or perforated styles.

Readers' Service Item P-3

Plastic Wall Tile Spacers

Permanently clean, uniform spaces between plastic wall tiles are assured by a recent development from Artcrest Plastics Co. Called Plastic Grout Strip, the polystyrene stripping keeps the panels or tiles exactly 1/10-inch apart. Unlike paste or cement grouts which are porous and, therefore, subject to dust and dirt infiltration, the plastic strips are wiped clean instantly with a wet cloth.

Polystyrene strips keep plastic wall tile panels exactly 1/10-inch apart.

Even the most expensive ceramic tile installations use paste or cement which eventually becomes yellow or dirty. In the case of plastic tile, often selected by the do-it-yourselfer, a major problem is the virtual impossibility of keeping the lines straight and even.

Plastic wall tiles already used are in 30-35% of all new homes, and Artcrest officials expect their newest development to expand this market still further. Polystyrene material used for the stripping was supplied by Catalin Corp. of America.

Readers' Service Item P-4

Phenolic Base for Neon Sign

Four-inch square phenolic bases for neon-lighted letters and numbers are being molded by U-Change Neon, Inc. The phenolic material, supplied by the Durez division of Hooker Electrochemical Co., is static-free, lightweight, self-insulated, unaffected by sudden temperature changes, moldable to close tolerances, and inexpensive to install and repair.

The Appleton Studio

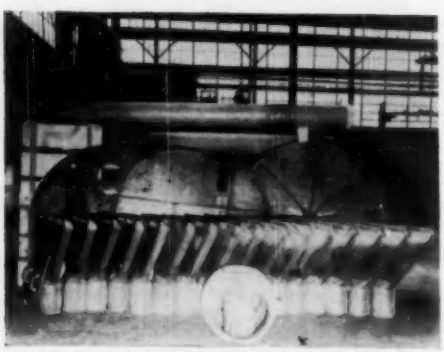
Interlocking phenolic squares serve as the base for neon sign. Molded phenolic caps insulate letter sockets against moisture.

The phenolic blocks, each holding an individually-lit letter or character, slide together by the tongue-and-groove method. This feature makes it possible to lengthen or shorten the sign to any desired specification. For complete weatherproofing, a pliable weather seal fits on the electrode and seals off moisture. Caps cover letter sockets not in use, and top and bottom flanges seal off moisture at the tongue-and-groove points of assembly.

The black phenolic bases are approved as non-conductors by fire insurance underwriters, and form a neutral background for the neon letters. The signs use a specially-constructed transformer of either 7,500 or 9,000 volts, depending on size. A transformer with four attached blocks (or bases) forms the primary power unit for each sign.

The neon letters range from 4-24 inches in height, with proportionally-larger base squares. These letters are available in block or script style, single or double tubulation, or as numbers and figurines. Six neon colors can be obtained: turquoise, green, rose, blue, amber, and white. Con-Don Co. serves as national distributor for U-Change neon signs.

Readers' Service Item P-5



Industrial items molded from Haveg resin.

Reinforced Plastic Equipment

A complete line of tanks, fume ducts, hoods, towers, trays, and other process equipment, said to offer greater chemical resistance than standard reinforced-polyester equipment at no extra cost, has been introduced by Haveg Industries, Inc. A new, glass-filled formulation, Haveg 6610, is the material of construction.

Haveg 6610 is reported to offer improved fire resistance and impact strength over standard polyesters. It will not support combustion. Molding techniques are essentially the same as those employed with any polyester-glass combination.

Readers' Service Item P-6

Reinforced plastic panels frame the glass insert in Fiberglo storm and screen door.

Paneled Storm-Screen Door

A combination storm and screen door, with reinforced plastic panels flanking the interchangeable glass and screen inserts, has been introduced by Alumacraft Mfg. Co. Called Fiberglo, the door's frame is extruded from 63ST5 aluminum, with heavy-gage aluminum kick plate. The translucent side panels are fibrous glass-reinforced polyester, tinted in any of the following six colors: blue, green, cherry, pink, yellow, and white.

The Fiberglo door is 1-⅛ inch thick, and is installed on a full-length piano hinge. The plastic framing-panels are non-breakable, easy to clean, and afford a certain amount of thermal insulation.

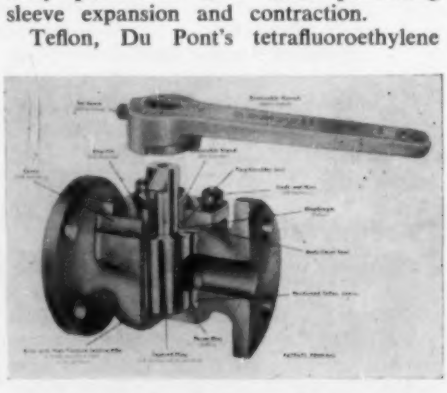
Readers' Service Item P-7

Teflon-Sleeved Valves

A line of Teflon-sleeved, stainless steel plug valves has been introduced by Continental Mfg. Co. Trade name Tufline, the valves have internal ribs which lock the sleeve in position. This provides for high-pressure continuous sealing around body ports and bore while permitting sleeve expansion and contraction.

Teflon, Du Pont's tetrafluoroethylene resin, eliminates the need for any lubrication. Plug rotation is limited to one-quarter turn by stops in the valve cover. The shield-type wrench is epoxy-coated, and the valve itself is fully enclosed with metal for maximum protection against fire or line shock.

Tufline valves are recommended for liquid and gaseous corrosives, solvents, slurries, and for hydraulic and pneumatic services where standard valves will not seat due to entrained solids. The valves are 150-class, and will operate continuously at temperatures ranging from –150° F. to +400° F. They are available in sizes of ¼-2 inches, with either screwed or flanged ends, and in various stainless steels and alloys.

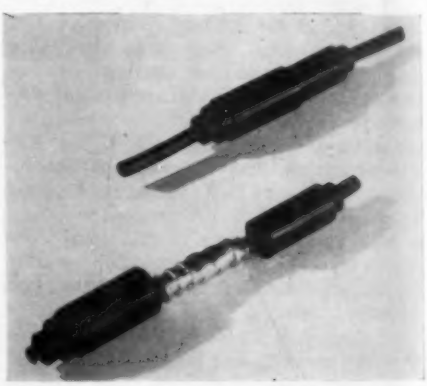


Teflon-sleeved stainless steel plug valve.

Readers' Service Item P-8

Plastic Wire-Splice Cover

A two-piece, moisture-proof cover for electrical wire splices has been developed by Plastic Engineering & Sales Corp. Molded from Du Pont's Alathon polyethylene resin, the tubular sections slide together to form an overlapping seal.



Polyethylene wire-splice cover.

Assembly requires about 15 seconds.

A special, black-pigmented formulation is employed in industrial installations where appearance is unimportant. Molded-in O-rings provide for close fit, yet allow easy separation. The wire-entry port admits a range of wire thicknesses from No. 6 to No. 2.

Readers' Service Item P-9

System for Ceiling Lighting

A modular, interchangeable, plastic-panel system for fluorescent ceiling lighting has been introduced by Sylvania Electric Products, Inc. Called Sylva-Lume, the system allows a wide variety of custom designs from a few standard parts. It was developed by Sylvania in collaboration

Classroom with Sylva-Lume ceiling lighting.

with Peter Muller-Munk Associates, an industrial design firm.

Major elements of the Sylva-Lume system are the "Outrigger" fixtures, vinyl diffusers, acoustic wedges or baffles, perimeter panels, and the track system. The first-mentioned item, a ladder-type, bare-lamp fixture can be six or eight feet in length, is H-shaped, and can accommodate four four- or eight-foot fluorescent lamps.

The three-foot square vinyl diffusers are available in three different designs, and in a variety of pastel colors. These panels come single- or double-layered, and in shallow, deep, or drum-head styles. The three-foot by five-inch perforated steel baffles are filled with glass fibers. White, yellow, and blue in color, they provide sharp delineation of color as a contrasting medium.

The flat-steel perimeter panels have swiss-cheese holes, and are backed by plastic. Available in three-foot squares, they can be cut with tin shears and used anywhere in the ceiling. The extruded-aluminum, suspension-grid track system is hung from the fixtures, and supports the diffusing panels, perimeter panels, and baffles of the lighting system.

Readers' Service Item P-10

Polyethylene Beer—Keg Corks

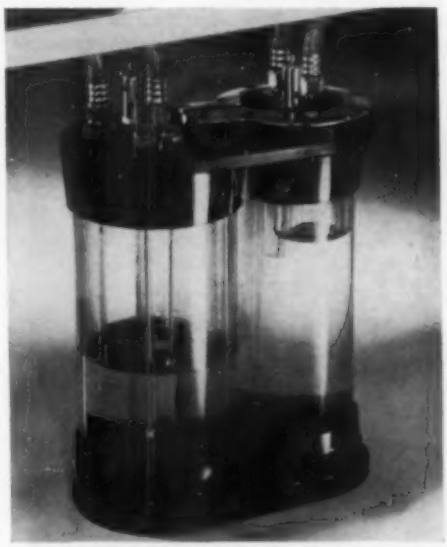
Polyethylene tap corks for beer kegs reportedly achieve a tighter seal under the pressure of carbonation than natural cork. Injection molded by Armstrong Cork Co.'s glass & closure division, the corks are center-gated for even distribution of material. There are no weld lines or thin areas.

Polyethylene tap corks for beer kegs.

Flat heads and tapered-lead tips assure straight driving of the closures, and an arched support gives the dome sufficient strength to prevent piercing by the tap rod. Locking lobes are designed to give during insertion, then snap firmly against the underside of the bushing without rupturing or splitting. A stiff sealing-ring, supported by the arched dome, seals the deeper grooves in the bushing. A lower, semi-stiff ring, supported by the interior rib, seals-in the Peerless bushings. The sides of the closure flare outward toward the tip lock.

Polyethylene corks are said to be less costly than natural tap corks, and to seal pressures many times higher than beer will produce. In addition, the material has no taste or odor, will not decay, and will not support mold growths.

Readers' Service Item P-11



Carbonator features butyrate housing.

Small Motorless Carbonator

A small-size, motorless, pumpless carbonator for dispensers of carbonated beverages has been placed on the market by Wilshaw Enterprises, Inc. Called the Yan-Nell Jet Carbonator, the unit has a transparent housing of Tenite butyrate, a product of Eastman Chemical Products, Inc.

The standard model has a capacity of 30 gallons per hour, operating at a water pressure of 20 pounds. Larger capacities are possible by using higher water pressures, or by heightening the carbonator. When necessary, Yan-Nell will operate on gravity-fed water. Minimal maintenance problems are assured by the elimination of all but one movable part.

The carbonator body consists of two cylindrical chambers. Water is carbonated in the charging chamber under constant pressure from a 60-pound gas line, which gives saturation-point carbonation. When the charging chamber falls to the refill level, an electrical relay opens a valve to permit the intermittent entrance of carbonating gas. This line is connected to the reservoir chamber, and acts in place of a pump. The reservoir is replenished from the main water line, and a float valve makes the sole move in the cycle.

Because of its small size, the carbonator permits the installation of vending machines in areas where they were excluded previously by space consderations. The transparency of the butyrate housing, plus the attractive appearance of the stainless steel fittings, makes it possible to display the carbonator to full public view. Three commercial sizes are available.

Readers' Service Item P-12

Reinforced Plastic Boat-Decks

The Fiesta and Islander, two sport-model boats produced by Blue Mfg. Co., are said to offer speedboat appearance at outboard prices. These boats feature aluminum hulls topped by one-piece, fibrous glass-reinforced polyester decks. These decks have an impact strength more than seven times that of most metals.

Other uses of plastics in the boats include vinyl hull paints, foamed plastic insulation for the seat chambers, vinyl upholstery, and acrylic windshields. Both models are available in a rainbow assortment of two-tone color effects, and differ primarily in size. Polyester resin used in the decks is Plaskon, a product of Allied Chemical & Dye Corp.'s Barrett Division.

Outboard boat with reinforced-plastic deck.

Readers' Service Item P-13

New Literature

Write item numbers on Readers' Service card to obtain copies.

"Permagile." Permagile Corp. of America. 6 pages. Three new plastic compounds for joining, filling, cladding, and surfacing masonry materials are described in this illustrated brochure. Properties and use instructions for the compounds are given, together with a list of industrial and governmental users.

Readers' Service Item L-1

"Wittek Sure-Tite All Stainless Steel Clamps for Plastic Pipe." Wittek Mfg. Co. 2 pages. This illustrated bulletin gives general specifications and descriptive data on the firm's Series P and PS clamps.

Readers' Service Item L-2

"The 'Sonite' System for Epoxy Resin Case Molds." Technical Bulletin 17. Smooth-On Mfg. Co. 4 pages. The company's newly-developed system for making case molds from epoxy resins is described in detail, covering such phases as preparation, sealing, and parting of the block mold; mixing and applying the resin; and the backing-up process. The finished molds have a hard, glassy surface; reproduce the most minute details; and usually eliminate the need for soap sizing.

Readers' Service Item L-3

"Vacuum and Drape Forming Machines." Vacuum Forming Corp. 16 pages. The operation of the company's VacTrim machine for vacuum forming, drape and plug forming, and automatic trimming of formed sheets is described and illustrated. Construction features of the machine are discussed in detail.

Readers' Service Item L-4

"The Hand Lay-Up System of Epoxy Resin Laminations," Technical Bulletin No. 22. Smooth-On Mfg. Co. 4 pages. The most widely used system for making glass-reinforced epoxy impressions for use in metal-working, and for model and pattern reproducing, is discussed. Procedures are described for preparation of models of plaster, wood, metal, and other non-porous materials, and information is given on handling, mixing, and weighing of the ingredients, and the care of tools and brushes.

Readers' Service Item L-5

"The PE Series." Technical Bulletin 220. Claremont Pigment Dispersion Corp. 6 pages. Complete data is given on this series of granular color concentrates for polyethylene.

Readers' Service Item L-6

"A Guide to Machining Stainless Steels." Slide Chart. Carpenter Steel Co. One side of the chart gives concise data on turning, drilling, tapping, threading, milling, and reaming. It tabulates speeds and feeds, and gives special notes on drilling, tapping, lubrication, and welding. The other side shows the workability of stainless steels in blanketing, deep drawing, stamping, forging, heading, roll threading, and welding. Should be of particular interest to mold makers.

Readers' Service Item L-7

"Packaging with Plastics." Volume 3, No. 1. Bakelite Co. 12 pages. Such new applications of polyethylene are described and photographed as packaging of radio frequency connectors, cake mixes, linens, dairy products, and ducks.

Readers' Service Item L-8

"Product Engineering Bulletin." No. 1, 1957. E. I. du Pont de Nemours & Co., Inc., polychemicals department. 8 pages. Mechanical, chemical, electrical, and electronic applications of Teflon are given, along with a description of new applications for Alathon and Zytel. Numerous photographs and property data are included.

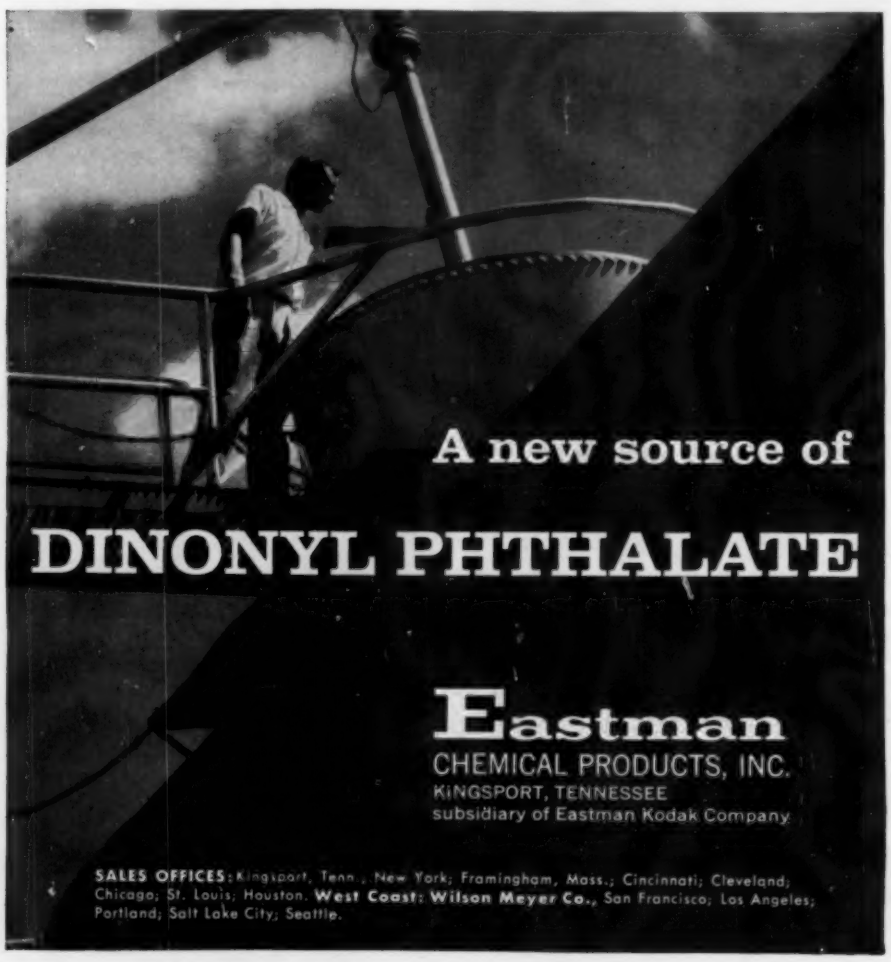
Readers' Service Item L-9

"Nylaflow Pressure Tubing." Bulletin BR-3A. Polymer Corp. of Pennsylvania. 4 pages. Characteristics, installation, and advantages of the flexible polyamide tubing are listed, along with available sizes, in this illustrated bulletin. Also depicted are a new flaring tool, tube cutter, tube-bending clips, and a heat-bending tool.

Readers' Service Item L-10

"Fluoroflex-T Laminated Pipe." Bulletin FTL-2. Resistoflex Corp. 4 pages. Specifications, design, construction, and applications are given for this chemical-resistant piping, which is made from woven glass fabric impregnated with Teflon tetrafluoroethylene resin. Molded bellows, dip pipe, and special applications are included.

Readers' Service Item L-11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Book Reviews

"Engineering Inspection Manual." Henry A. Roy. Chemical Publishing Co., Inc., 212 Fifth Ave., New York 10, N. Y. Cloth, 5½ by 8¾ inches, 160 pages. Price, $5.75.

Although quality must be built-in with a given part and cannot be inspected-in, carelessness and neglect during inspection is unforgivable. This is the premise of this work written by a chief inspector for inspectors engaged in machine tool, aircraft, and other mechanical inspection.

Every important inspection method and tool is illustrated and decribed in great detail. The text gives actual situations, short-cuts, and rule-of-thumb procedures. In addition to explaining every type of caliper, protractor, and gage, the book has sections on nomenclature, calculations, and formulas. The appendix includes tables of constants, conversion factors, and dimension standards for wires and threads.

"Symposium on Corona." ASTM Special Technical Publication No. 198. American Society of Testing Materials, 1916 Race St., Philadelphia 3, Pa. Paper, 6 by 9 inches, 32 pages. Price, $1.25.

Corona, that discharge of electricity which appears on the surface of a conductor when the potential gradient reaches ionizing levels, has been a problem to manufacturers and users of organic electrical insulation. Research has been conducted independently, with the result that there is no common or standard methods of corona detection, nor are there published evaluations of the corona resistances of insulating materials.

In 1954, ASTM organized Section L on Corona Tests under Subcommittee XII on Electrical Tests, of Committee D-9 on Electrical Insulating Materials. This Section set out to devise test methods for determining the presence of voids in dielectrics which, in turn, may be ionized under high-voltage gradients; and to differentiate among electrical insulating materials with respect to their corona resistances.

A symposium on this subject was held in November, 1955, during the ASTM D-9 meeting in Cincinnati, O. Papers, covering the following topics, were presented: "Preliminary Corona Resistance Test Results from IEC Activities," "Effects of Corona on Thermosetting Plastic Laminates," "Corona Resistance Test Method for Laminates, Molded, and Cast Materials," "Corona Detection and Measurement at Sixty Cycles," and "Test Methods for Measuring Energy in a Gas Discharge." Papers are published in toto, with graphs and illustrations.

"Materials and Processes in Manufacturing." E. Paul DeGarmo. Macmillan Co., 60 Fifth Ave., New York 11, N. Y. Cloth. 6¼ by 9½ inches, 765 pages. Price, $8.50.

This excellent book, written for the college engineering student, is both clear and concise. It gives the reader a first-hand acquaintance with materials, machine tools, and manufacturing methods, with emphasis on manufacturing. Metallurgy is handled from the practical viewpoint, rather than the theoretical. Illustrations have been selected for the beginner, and are basic in nature.

Metals, alloys, and plastics are covered under the materials section; including their properties, production, testing, an equilibrium. Casting and forming processes are described in another section, which explains sand-casting, permanent mold, die, centrifugal, precision, investment, and shell-casting methods. The section on machining processes covers measurement and gaging, cutting, shaping, planing, drilling, reaming, turning, boring, milling, and other finishing operations.

Forge-, gas-, arc-, and thermit-welding are described in Part 4, along with resistance welding, torch- and arc-cutting, brazing, and soldering. Part 5 covers layout, jigs, fixtures, decorative- and protective-coating techniques, and mass-production methods. A three-page appendix of selected references is included.

"British Plastics Year Book 1957." 27th Edition, Iliffe & Sons, Ltd., Dorset House, Stamford St., London S. E. 1, England. Cloth, 6½ by 9¼ inches, 716 pages. Price $5.90.

This classified guide to plastics manufacturers and products in the United Kingdom contains nine tabbed sections, each revised from earlier editions. Three sections give classified lists of manufacturers and suppliers of materials, finished items, and equipment. Another section lists trade and proprietary names for both materials and products. Each trade name is followed by a description of the product, the manufacturer, and his corporate address.

Over 4,000 firms are listed in the names and addresses section. Who's Who records the names and positions of prominent men in the British plastics industry. Still another feature is the annual review of plastics patents, 142 pages in all, abstracted according to subject group. This same section includes a list of new plastics companies registered in 1956, plus a listing and description of British standard specifications.

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Abstracts of Important Articles

Materials

"Specifying Vinyls," W. Waychoff and P. Spink, *Materials & Methods,* 45, 1, 116 (Jan. 1957).

Realistic review of vinyl specifications showing what properties are obtainable, and which must be sacrificed for others in specific applications.

"'Zytel' Nylon Resin—A Versatile Engineering Material," W. C. Warriner and A. J. Cheney, *Mech. Eng.,* 78, 12, 1118 (Dec. 1956).

A discussion of engineering properties of Zytel, including specific gravity, and resistance to wear, abrasion, impact, weathering, chemical attack, and oxidation.

"Epoxy-Butadiene Resins," C. G. Fitzgerald, A. J. Carr, M. Maienthal, and P. J. Franklin, *SPE J.,* 13, 1, 22 (Jan. 1957).

Liquid polybutadiene was epoxidized with peracetic acid in chloroform solution, and a range of epoxy-butadiene resins prepared. Electrical properties of these resins are examined as functions of temperature and frequency.

"Effect of Ratio of Diisocyanate Isomers in Polyurethane Foams," G. T. Gmitter and E. E. Gruber, *SPE J.,* 13, 1, 27 (Jan. 1957).

Isomer ratios are discussed in terms of foam formation and height, reaction complexity, fissures, and use of foam machines.

"High Temperature Anhydride Cures," John Delmont, *Western Plastics,* 3, 11, 15 (Nov. 1956).

A detailed discussion of anhydride curing systems for epoxy resins, with emphasis on effect of material variations, post-curing, and application variables.

"Study of the Phenomenon of Impact—The Special Case of Lucoflex," J. Lesavre, *Ind. Plastiques Mod.,* 8, 7, 41 and 8, 8, 51 (July-Aug. & Sept.-Oct., 1956).

The present study on impact behavior of Lucoflex rigid PVC also aimed at discovering how best to express results of impact tests and how reliable are the apparatuses used in the Charpy and Izod tests. The results of a large number of tests were worked up statistically. It appeared that the phenomenon of impact is two-fold, according as a sample breaks freely or resists, and it was found desirable to express results of impact as fragility or impactance. Impactance (high level resistance) is the physical quantity measured in the case of non-rupture, and fragility is measured in the case of free fracture. Both the Charpy and Izod tests are very well adapted to determining impact resistance, and their results are of the same order. Although fragility cannot be measured very accurately yet, it is of practical importance, as it permits comparison of various materials and prediction of the energy absorbed by a bar of given dimensions. (In French).

"PVC Pastes—Theory and Practice," M. S. Welling, *Plastics,* 21, 225, 121; 21, 226, 161; and 21, 227, 194 (June, July, August 1956).

In the three parts of this article, the author deals successively with the factors to be considered in PVC paste formulation and the various processes in which these formulations are used, aiming at presenting a complete picture of the constituent materials of the pastes and the technology of application. He considers spread-coating of fabrics and finishing methods; the elastomer process and blowing methods for producing open and closed cell types of cellular PVC; hot and cold dipping techniques; and slush molding.

"Quick Method of Conditioning Plastics for Humidity Control," F. Ecochard and G. Berchet, *Ind. Plastiques Mod.,* 8, 8, 33 (Sept.-Oct., 1956).

The method is based on the diffusion equilibrium between a polymer and an aqueous solution of a salt, the chief advantage being that a state of equilibrium can be obtained in a much shorter time than by the usual methods. Samples of polyamide immersed in a suitable aqueous solution of potassium acetate at 100° C. developed a uniform humidity of 3.5% in five hours, instead of in 30 hours by the usual method. Tests were carried out only on polyamides, but the method may have possibilities for other plastics. (In French).

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in June.

"Practical Experience with Styropor," F. Stastny, *Plastverarbeiter,* 7, 8, 286 (Aug. 1956).

The method of producing foamed Styropor and Styropor blocks and plates, and their mechanical properties and applications are considered. Results are given of tests on thermal, insulation, acoustic, hygroscopic, and heat-conductivity properties. Tests on mold resistance, effect of moisture on heat conductivity, and dimensional stability of Styropor-wood veneer sandwiches also are briefly described. Mention is made of a special Styropor P grade that is resistant to mineral oil and gasoline. (In German).

"Polymerization of Vinyl Chloride and Structure of Polyvinyl Chloride," G. Bier and H. Kramer, *Kunststoffe,* 46, 11, 498 (Nov. 1956).

The authors describe the present state of our knowledge on the mechanism of vinyl chloride polymerization and the structure of PVC, drawing on the literature as well as on results of their own recent experiments. The reactions of chain transference and rupture are discussed thoroughly, and the presence of double bonds in the polymer is made probable. Other groups (residues of emulsifiers and catalysts) also could be identified in the polymer. The presence of traces of emulsifier was found to affect slightly the molecular weight. The degree of branching depends on the method of polymerization; products prepared by different methods showed differences in the Zn/M relationship. After reduction with lithium aluminum anhydride and infra-red analysis of the resulting polyethylenes, little or no branching was found in these products. The effect of a second vinyl compound on the composition of a vinyl chloride copolymer is illustrated by the example of vinyl chloride/vinyl acetate. (In German).

"Critical Temperatures of a Series of Peroxides in Polyester Resins," J. W. Cywinski, *Brit. Plastics,* 29, 10, 377 (Oct. 1956).

Investigations of critical temperatures were carried out by determining polymerization curves showing the temperature rise in polyester resins under the influence of the exothermic reaction in the presence of various peroxides. The process is similar to the proposed method for de-

termining gelling time, except that instead of one bath, use is made of a series of glycerine baths of temperature ranging from 50-120° C. From the polymerization curves, gelling times and minimum cure times can be calculated for each peroxide at different temperatures.

"A Special Mechanical Test: the 'Brazilian' Test," J. Lesavre *Ind. Plastiques Mod.*, 8, 10, 48 (Dec. 1956).

The "Brazilian" or "splitting" test was intended for testing concrete, and both Japan and Brazil claim priority for it. The test is carried out almost exactly like a compression test, with a right circular cylinder specimen being placed on the dynamometer between two compression plates, except that the axis of the cylinder is placed transverse, instead of parallel to the direction of compression. If operations are conducted at a sufficiently low temperature, the test also can be used for plastics. The author discusses the use of this test on polyester resins modified by two different, but chemically similar, decolorants, each present in eight different concentrations, and the aim was to discover whether and at what concentration the discolorants affect mechanical properties. It is shown that while flex and impact tests give no satisfactory information in this regard, the Brazilian test yields results which faithfully reflect the varying content of decolorant in the polyesters. The test is recommended without reservations for its simplicity and precision. (In French).

"High Density Polyethylene," J. S. Gourlay and M. Jones, *Brit. Plastics*, 29, 12, 446 (Dec. 1956).

The commercial methods of producing high-density polyethylene are reviewed, and the British product, Alkathene HD, is compared with the conventional Alkathene 2. The feature of the former is considered in cable-making, for pipe, and in injection moldings, all fields in which Alkathene 2 now is chiefly employed in Britain. A new potential application for high-density material, as reinforcement for rubber, also is mentioned.

"Theoretical Study of Polyethylene Permeability," Jules Pinsky, *Modern Plastics*, 34, 9, 145 (April 1957).

An attempt to bridge the gap between the theoretical chemist and the practicing engineer so that applications of the thermo-dynamic problems involved in polyethylene permeability can be made.

"Practical Methods for Controlling the Effect of Moisture on Molded Nylon," W. B. Happoldt, A. J. Cheney, and E. M. Lacey, *SPE J.*, 13, 3, 21 (March 1957).

The rate of moisture absorption and the effect on dimensions are discussed, together with typical changes in an air environment and in varying environments. Conditioning methods are described in detail, including conditioning in salt solutions, in steam, and in boiling water.

Equipment

"Vent Valve for Compression Molds," G. W. Wilcox, *Modern Plastics*, 34, 6, 132 (Feb. 1957).

A tiny vent valve built into compression molds will eliminate bulging and sinking of molded parts due to trapped gas or unrelieved suction.

"Multipurpose Coating Machine," H. Devant, *Kunststoffe*, 47, 2, 74 (Feb. 1957).

As hitherto designed, multi-purpose spreaders have presented various difficulties in regard to accessibility and interchangeability of parts. These difficulties, it is claimed, now have been eliminated by a recently-patented, revolving coating machine which permits rapid and simple conversion to four different spreading methods. (In German).

"Continuous Winding Machinery for Plastic Film and Sheeting," J. E. Nordgren, *SPE J.*, 13, 4, 23 (April 1957).

A discussion of film and sheet winding methods and equipment, including surface winders and center winders made by the Dilts Machine Works Div., Black-Clawson Co., Inc.

"Engineering of Molds Using Electroformed Molds," W. J. B. Stokes, II, *SPE J.*, 13, 3, 29 (March 1957).

The manufacture, uses, and advantages of electroformed molds are described.

"Advantages of Dual Thermocouples in Injection Cylinders and Extrusion Barrels," R. K. West, *SPE J.*, 13, 4, 40 (April 1957).

Advantages of the dual thermocouple are discussed, and it is shown that this equipment provides for a wider range of extrusion conditions than can be obtained with standard single thermocouples.

"Application of Light Diffusion to the Study of Linear High Polymers," H. Benoit, *Ind. Plastiques Mod.*, 8, 10, 53 (Dec. 1956).

A description of the apparatus used for such light-diffusion tests on solutions of linear macromolecules at the Centre de Recherches sur les Macromolecules, Strassburg, is followed by interpretation of results. It is shown that, in principle, study of angular distribution of the diffused light enables information to be obtained on polydispersity, the degree of branching, and the statistics of chains. (In French).

"Modern Testing Equipment for Packaging Materials," H. Rodenhauser, *Plastverarbeiter*, 7, 7, 274; and 7, 8, 310 (July & Aug. 1956).

Descriptions of a number of German devices for testing permeability, cold resistance, bursting and bending strengths, stiffness, blocking, buckling, and abrasion resistance. (In German).

"A New Method of Mixing and Compounding Plastics in a Single Operation," P. Pilz, *Kunststoffe*, 47, 2, 64 (Feb. 1957).

In this method, the fluidizing effect of aerating powdered or granulated plastics is utilized to mix and compound them like fluids. A machine is described which employs available air in the container and vortex-type mixing to produce a slight degree of aeration, sufficient to give the materials flow characteristics corresponding to those of medium- or highly-viscous fluids. This permits the peripheral velocity of the rotor to be increased considerably. The principle of vortex-type mixing also makes it possible to construct a machine of very simple design requiring a minimum of servicing. (In German).

Processing

"Factors Affecting Quality in Polyethylene Extrusion," B. H. Maddock, *Modern Plastics*, 34, 8, 123 (April 1957).

A report on an investigation showing the effects of design and operating factors on two aspects of extrudate quality; dimensional stability, and mechanical homogeneity. Tests were performed on two-inch extruders using polyethylene having a melt index of 2.0. In general, extrudate quality is shown to be improved by increasing the back pressure or by increasing the mechanical work of temperature.

"Formvac Airslip Process — A New Vacuum-forming Process," P. Sauter, *Kunststoffe*, 47, 1, 23 (Jan. 1957).

The disadvantages of the usual drape-forming process, particularly for deep articles with more or less vertical sides, are the need for larger allowances around the edges (which increases costs and wastes material), uneven thickness of walls, and reduced strength of vertical side-walls because of unilaterial stretching. These disadvantages are avoided by the Formvac Airslip process of the Hydro Chemie A.G., Switzerland, in which the heated sheet is

blown up uniformly during the pre-forming operation by hot air under controlled pressure. Large objects such as refrigerator linings, as well as small containers of various sizes (some only 0.15 mm. thick), can be made by this method. (In German).

"Volume and Pressure Effects in Compression Molding," W. R. McClone and L. B. Keller, *Modern Plastics*, 34, 7, 173; 34, 8, 137 (March & April 1957).

The two parts of this article deal with measurements of punch movement during compression molding in unlanded and landed molds, respectively.

"Pressure Preforming," S. H. A. Young, *Modern Plastics*, 34, 7, 161 (March 1957).

Description of a one-step preforming process that makes precision preforms of sharply varying cross-sections.

"The Molding of Linear Polyethylene," F. J. Reilly, V. Hill, and D. A. Jones *SPE J.*, 13, 4, 28 (April 1957).

The effect of gating on the molding of linear polyethylene was studied, and it is shown that gate size and design greatly influence the shrinkage and impact strength of moldings made from the material.

"Polyethylene Fibers," A. T. Widiger, G. H. Youse, and T. C. Broadwell, *SPE J.*, 13, 4, 32 (April 1957).

Conventional monofilament fabrication equipment is shown to be suited for the extrusion of linear polyethylene polymers, with only slight modifications. The properties of this material appear satisfactory for many of the present applications for melt-spun fibers. Stabilization of the polymers against oxidation and ultraviolet radiation is an important consideration, and progress to date on this aspect is described.

"Valve Extrusion," E. C. Bernhardt, *SPE J.*, 13, 2, 17 (Feb. 1957).

An SPE Conference paper giving a detailed study of a method of interrupted extrusion. The technique is shown to be suited for production of uniform shots of molten polymer in rapid series, especially in series with simple forming operations.

"The Molding of Thick Polyester Laminates," Finn Claudi-Magnessen, *SPE J.*, 13, 3, 36 (March 1957).

An SPE Conference paper showing that internal delamination of thick laminates of glass-polyester results from too short molding cycles and from too high internal temperatures. Recommended molding procedures are given to produce void-free, thick laminates.

"Preparing Metallic Surfaces for Plastics Coatings," E. F. Anderson, *Plastics World*, 15, 3, 10 (March 1957).

A discussion of blasting methods and equipment.

"New Gating for Acrylics," J. F. Moore, *SPE J.*, 13, 3, 17 (March 1957).

A discussion of "tab gating" and its advantages. "Tab gating" is the use of a tab or vestibule instead of the usual gate, and molten plastic enters the tab from the side through a restricted entrance. Advantages can include lower mold cost and better physical properties of molded parts.

Applications

"Thermoplastic Pipe," B. Kellam, *SPE J.*, 13, 1, 31 (Jan. 1957).

The effects of environments, electrical properties, and compatibility properties of thermoplastic pipe are discussed, together with pipe evaluation, applications, and installation.

"Modified Synthetic Resins for Film-forming Protective Finishes," R. Hinterwaldner, *Kunststoff-Rundschau*, 3, 8, 285; 3, 9, 330 (Aug. & Sept. 1956).

The film-forming finish chiefly discussed in polyurethane product in which the polyester has been modified with a special silicone resin, and has been placed on the market recently by a German firm under the name, Corr-Unit. The reactive components (the polyester and the diisocyanate) are sold separately, and the addition reaction can be regulated and, hence, the elasticity of the film. The material is sprayed onto metal, wood, or concrete surfaces in successive layers to the desired total thickness, providing a surface that resists all but a few in a list of 60 chemicals at 20° C., and a good number at 50° C. It does not resist oxidizing acids, nor phenols and cresols containing water. The finish stands heat up to 200° C., moist heat to 150° C., and cold to —194° C. Other properties of the material are described, as are its use on tanks in the chemical industry, in the bulk transportation of milk and spirituous liquors, etc. (In German).

"Importance of PVC Products for the Packaging Industry," H. Hook, *Plastverarbeiter*, 7, 7, 263 (July 1956).

The products discussed include several types of plasticized and unplasticized PVC film and tubing for packaging, as well as a liquid plasticized-PVC product for obtaining protective coatings by spraying, dipping, or coating. All of these products were developed by Anorgana G.m.b.H., of Munich. (In German).

"Plastics for Packaging," L. Mangini, *Materie Plastiche*, 22, 8, 619 (Aug. 1956).

Advances in the use of various types of plastic packaging materials made in Italy during 1952-1955 are reviewed. Applications of urea resins, Moltoprene, PVC, polyethylene, and polystyrene are described. (In Italian).

"Stability of Nylon Parts in Business Machines," B. W. Nelson, *SPE J.*, 13, 3, 13 (Feb. 1957).

An SPE Conference paper describing nylon gears, clutch pinions, and other parts used in business machines, and showing the effect of relative humidity on the dimensional stabilities of these parts.

"Plastics Film Suitable for Packaging," W. Tiebel, *Plastverarbeiter*, 7, 7, 258 (July 1956).

The different kinds of plastic films commonly used in Germany for packaging are reviewed. The properties, applications, and methods of sealing are given for a list of materials, as well as the trade names under which they are sold in Germany. Specially-treated products, either coated or combined with other plastics or other materials, and new closures for boxes also are discussed. (In German).

"Plastics for Aircraft Structures." J. E. Gordon, *Rubber & Plastics Age*, 37, 8, 535 (August 1956).

The limit seems to have been reached by accepted methods in the development of reinforcing agents and organic bonding resins capable of meeting the demands of ever faster aircraft for greater temperature resistance, strength, and stiffness of material. The present article deals with the factors governing strength of materials, and refers to the Orowan-Polanyi free surface energy equation. It then goes on to discuss ionic crystals and the Joffe Effect, the strength of certain organic crystals. The author also refers to low-density materials, pointing to possibilities of a combination of a special hollow reinforcement and a solid resin.

"Plastics for Packaging Foodstuffs," L. Robinson-Gornhardt, *Kunststoffe*, 47, 2, 54 (Feb. 1957).

In view of the increasing use of plastics for packaging foodstuffs, the problem of possible toxicity of plastics, plasticizers, stabilizers, and other adjuncts is one of growing importance. The author reviews literature on the subject, citing chiefly American and French publications, but also referring to recent German information. (In German).

"Short-Run Plastics Parts Cast in Rubber Molds," I. R. Axelrod, *Materials & Methods*, 45, 2, 104 (Feb. 1957).

A technique similar to that used for making plaster novelty items is suitable for the molding of models, prototypes, and short-run plastic parts. Flexible neoprene rubber molds are used.

"Development of Plastic Pipe Standards," K. W. Kuhlmann, *SPE J.*, 13, 2, 33 (Feb. 1957).

A discussion of the development and current status of plastic pipe standards.

"Phenolic Coatings for Metal Products," R. B. Young, *Materials & Methods*, 45, 1, 106 (Jan. 1957).

A review of the resistance of the coatings to chemicals, abrasion, and mar, and their effects on coating applications.

"Bus of Plastic Material," M. Parducci, *Mat. Plastiche*, 22, 9, 743 (Sept. 1956).

At the 38th International Automobile Show in Turin, Italy, in 1956, was shown the first Italian bus with a body made entirely of plastic material. Sandwich structures, consisting of a core of expanded PVC or of polyethylene between glass-reinforced polyester or epoxy resins were employed. Details of the construction of this bus are described. (In Italian).

"Scientific Perspectives of Embedding. II. Chlorophyl Stabilization. III. Photac, the Photopolymerizable Plastic," J. Le Prevost and F. Cacheux, *Ind. Plastiques Mod.*, 8, 5, 16; 8, 6, 6; 8, 9, 5 (May, June, & Nov, 1956).

These three articles form a series on the problems connected with embedding in plastics. The first reviews ancient embalming methods, the forerunners of potting and embedment, and gives the requirements of synthetic resins for the latter purpose. In the second article, the chemistry of chlorophyl and the mechanism of photosynthesis are discussed as bases for the method, patented by the authors for the fixation of chlorophyl, which is a prerequisite for successful potting or embedding of biological, botanical, and similar specimens. The preparation of the specimen is described in general terms. The last article deals with the photopolymerizable plastic, Photac, a polymethacrylate said to have remarkable optical properties. Large blocks can be formed from it in one operation, instead of in successive layers, in a relatively short time. Its properties and uses are described not only for potting, but also for industrial applications impossible with the usual acrylics. Thus, a part for a combustion chamber (10 inches thick, almost six feet long, and weighing about 154 pounds) was polymerized in a single operation; the first time, it is claimed, that a casting this size has been made anywhere. (In French).

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Patent Digest

Materials

Copolymer of Trifluorochloroethylene and Vinylidene Chloride and a Method of Manufacturing Same. No. 2,770,615. Charles O. Kroncke, Jr., Bayonne, N. J. (to M. W. Kellogg Co., Jersey City, N. J.).

Between 20 and 98 mol percent of vinylidene chloride and 2-80 mol percent of trifluorochloroethylene are polymerized in the presence of a halogenated acyl peroxide at a temperature between —20° C. and 20° C., to produce a thermoplastic copolymer.

Purification of Acrylonitrile. No. 2,770,644. Marvin L. Owens, Jr., Texas City, Tex. (to Monsanto Chemical Co., St. Louis, Mo.).

Acrylonitrile containing methyl vinyl ketone is treated with a small amount of hydroxylamine hydrochloride.

Production of Synthetic Resins by Reaction of Diolefin Polymers with Sulfur Dioxide. No. 2,770,603. Charles S. Lynch, Bartlesville, Okla. (to Phillip Petroleum Co., Bartlesville, Okla.).

An unsubstituted, conjugated diolefin and a conjugated diolefin containing one substitute radical such as phenyl, alkyl, cyano, isocyanate, thiocyanate, and alkoxy, are polymerized in an aqueous emulsion to form a latex. This substance is reacted with sulfur dioxide to form a heteropolymeric latex.

Polyethylene-Oleamide Composition. No. 2,770,609. Albert Edward Symonds, Jr. Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The composition contains polyethylene and 0.01-0.5% by weight of an oleamide.

Plastic Printing Plate and Molding Composition for the Manufacture of Plastic Printing Plates. No. 2,768,146. George W. Bainton, Jr., Pittsfield, Mass. (to General Electric Co., Schenectady, N. Y.).

About 36-40% of a resinous material composed of a phenolic resin and hexamethylenetetramine, 5-12% of a butadiene-acrylonitrile copolymer, 8-12% asbestos floats, 18-28% ordinary woodflour, and 15-25% ground lignin-cellulose flour, make up the molding composition.

Process for Polymerizing Cracked Fractions Containing β-Methyl Styrene. No. 2,770,614. Thomas Heaton Howarth, John Downing, and James Gordon Napier Drewitt, Spondon, England. (to British Celanese, Ltd., Great Britain).

Beta-methyl styrene and indene, in a mixture of hydrocarbons which boil above 130° C., are polymerized in the presence of aluminum chloride and diethyl ether.

Melamine Resins Modified with Polyalkylene Polyamine-Halohydrin Condensates. No. 2,769,797. Tzeng Jiueq Suen, New Canaan, and Yun Jen, Stamford, Conn. (to American Cyanamid Co., New York, N. Y.).

Melamine, formaldehyde, and a polyfunctional aliphatic polyamine are reacted beyond the methylol stage, but short of the gel stage, at a temperature between 20 and 100° C. The reaction is stopped at 20-800 cps. viscosity, by neutralizing and adding additional formaldehyde.

Continuous Method for Making Solid Polymeric Materials. No. 2,769,804. Alden W. Hanson, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

At least two, copolymerizable, liquid, monomeric, vinylidene compounds are copolymerized, withdrawing the polymers from the reaction mixture. The incompletely-polymerized mixture is vaporized and returned to the reaction zone to effect a relatively continuous system.

Production of Vinyl Chloride Polymers. No. 2,771,457. Arthur William Barnes, Tewin, Bernard Stephen Dyer, Tewin Wood, Welwyn, and Austin Atkinson Gibson, Cleveleys, England. (to Imperial Chemical Industries, Ltd., Great Britain).

Vinyl chloride is polymerized with up to its own weight of an ethylenically-unsaturated copolymerizable material, in the presence of a water-soluble peroxy polymerization catalyst. Polymerization is initiated in the absence of an emulsifying agent, which is introduced after the polymer content has reached 0.5% and before coagulation.

Printed copies of patents are available from the Commissioner of Patents. Washington 25, D. C. Price, 25c each.

—The Editor

Method of Producing Fluorocarbons. No. 2,770,660. Herbert J. Passino, Englewood, Wilber O. Teeters, River Edge, and Russell M. Mantell, Orange, N. J. (to M. W. Kellogg Co., Jersey City, N. J.).

A fluidized mass of finely divided carbon particles containing fluorine is reacted with 8-12% by weight of an inorganic metal halide at a temperature of 375-925° F.

Melamine - Formaldehyde - Polyamine Condensation Product. No. 2,769,796. Tzeng Jiueq Suen, New Canaan, and Yun Jen, Stamford, Conn. (to American Cyanamid Co., New York, N. Y.).

Melamine, formaldehyde, and a polyfunctional aliphatic polyamine are reacted at a temperature of 20-100° C., until a viscosity of 20-800 cps. is reached. The material is then neutralized.

Equipment

Molding Apparatus. No. 2,769,202. Earl H. Thompson, Port Orchard, Wash.

The apparatus comprises male and female molds, one of which has a recess with a diaphragm covering. A pressure-reducing means communicates with the interior of the recess, and the sprue feeds the material into the cavity over the diaphragm. The pressure-reducing means draws the diaphragm into the recess during feed, thereby forming an expanded mold cavity.

Die Construction of Injection-Type Molding Machines. No. 2,770,011. George W. Kelly, Columbus, O. (to Columbus Plastic Products, Inc., Columbus, O.).

The die has a molding surface and a passage through which plastic materials are forcibly fed. This passage terminates in a discharge orfice embodying a plurality of angularly-disposed branches. An injection means forces the material through the passage, and the sprue cut-off pin, independently operated, seals the orfice to prevent back flow.

Sizing of Thermoplastic Cable Cores. No. 2,770,014. Henry G. Nordlin, Livingston, and Paul M. Koerner, Paterson, N. J. (to International Telephone & Telegraph Corp., Nutley, N. J.).

Thermoplastic material in cylindrical form is passed through a heated die, whose sizing hole is maintained at a substantially uniform temperature along its axial length. This sizing hole is of uniform bore, and is smaller in diameter than the cylindrical plastic. By thus accumulating the plastic, partial annealing can take place.

Apparatus for Extruding Thermoplastic Material. No. 2,771,636. Walter W. McIntosh, Indian Orchard, and John Moziek

and Oscar L. Smith, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

The extruder has an elongated casing defining a lengthwise bore, a rotatable screw, a transverse slot of uniform cross-section between the end of the screw and the discharge end of the casing, a sealably-fitting breaker plate assembly slideably mounted in the slot, and a removable stop means against which the breaker plate abuts to align the perforate portion with the bore.

Continuous Feeding and Slicing Mechanism for Plastic Substances and the Like. No. 2,770,039. Charles Doering and Henry H. Doering, Chicago, and Bertil J. Skoglund, Elmwood Park, Ill.

This mechanism for cutting uniform slices from preformed slabs of plastic consists of a rigid frame, a feed mechanism, a cutter frame, a reciprocally-moving cutter means, and a timing mechanism.

Extruding Press. No. 2,770,837. Hans Reifenhauser, Troisdorf, Germany. (to Hugo Stinnes Verwaltung G.m.b.H., Mulheim an der Ruhr, Germany).

The press consists of an elongated tubular casing with an elongated first inner cylindrical-surface portion, and a second inner portion coaxial with the first, and of larger diameter. A worm screw, coaxial with the casing, is rotated by means of axial grooves on the casing. A hopper is connected with the casing for feed purposes.

Presses for Molding Plastic Substances. No. 2,770,863. William Herbert Smith, East Molesey, England.

The block molding press consists of a mold box; frame; a ram guided for vertical movement; an articulated lever pivoted at one end to the frame and at the other end to the ram; a toggle mechanism connected at one end to the frame and at the other end to the lever; a rotary shaft; a crank arm with connecting rod to the toggle mechanism; a lever pivoted to the frame; a cam plate; a link mechanism; and a rotary cam.

Processing

Method for Producing Molded Products Comprising Melamine Formaldehyde Resin and Gypsum. No. 2,770,840. Lawrence P. Biefeld, Granville, and Richard F. Shannon, Lancaster, O. (to Owens-Corning-Fiberglas Corp., Toledo, O.).

The method comprises loading a mold space with a composition of water-soluble melamine-formaldehyde in an intermediate stage of polymerization, and calcined gypsum; the ratio being 1:2-8 by weight. Water is added to impart flow, but not more than theoretically required to form cement. A water-soluble, alkali-metal salt is added to "seed" the cement cure; sufficient acid is used to adjust the pH to 5-7; and glass-reinforcing fibers are added. The composition is molded under heat and pressure, removed, and hydrated.

High Speed Extrusion Composition No. 2,771,638. Martin Salo and Oliver W. Kaul, Rochester, N. Y. (to Eastman Kodak Co., Rochester, N. Y.).

The process involves dissolving cellulose acetate butyrate granules in a ternary solvent mixture consisting of 50% toluene, 10-30% hexane, and about 10% acetone. This mixture is extruded onto a metal strip at room temperature, and then cured.

Injection Molding of Polytetrafluoroethylene. No. 2,770,842. Oliver M. Hahn and Robert S. Mallouk, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The granulated polymer is preheated to 327-400° C., under a pressure effective to prevent melting. This material is injected into a closed mold maintained at a temperature below 327° C., under which conditions it melts instantly.

Process for Longitudinally Stretching Polymeric Film. No. 2,767,435. Francis Peter Alles, Westfield, N. J. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The film web is stretched lengthwise while in contact with a plurality of closely-spaced, parallel, cylindrical surfaces, each freely rotatable on an axis. These cylinders are in a plane parallel to the plane of the web, and are at right angles to the longitudinal axis. The distance betwen the cylinders should be no greater than five times the thickness of the web before stretching.

Method of Bonding a Polyamide Layer to a PVC Layer and Products Thus Obtained. No. 2,770,566. Franz Ritter, Grossostheim, Germany.

A substance selected from the group consisting of polyacrylic acid esters and polymethacrylic acid esters is deposited on a PVC layer. This is followed by a layer of a substance selected from the group consisting of nitrocellulose and PVA. This layer is followed by the polyamide layer.

Surfacing Resin Bodies. No. 2,769,742. Clarence H. Helbing, Milwaukee, Wis. (to Pittsburgh Plate Glass Co., Allegheny County, Pa.).

A laminate is formed by spreading a syrup of a condensation product of an aldehyde and triazine or urea upon a smooth, impermeable, supporting surface. The syrup is dried to a solid state, and a polymerizable layer of a polyester of alpha-beta-dicarboxylic ethylenically-unsaturated acid is applied. The sandwich is cured to a hard, coherent state, and stripped from the supporting surface.

Method of Molding Furan Resins. No. 2,768,408. Ralph F. Strigle, Jr., and Wiley Smith, Jr., Akron, O. (to Maurice A. Knight, Akron, O.).

A mold is filled with a mixture of viscous, thermosetting, exothermic prepolymer and a catalyst. Sufficient heat is applied to the closed mold so that the temperature rises at a faster rate than the exothermic reaction would induce. The mold is opened after the material sets.

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Current Market Prices

Price Changes and Additions

Resins & Molding Compounds

Cellulose acetate:			
Poly-Cell Group I	lb.	$0.50	/ $0.59
Group II	lb.	.46	/ .55
Group III	lb.	.38	/ .48
Group IV	lb.	.57	/ 66
Group V	lb.	.52	/ .61
Polyamide:			
Zytel, natural color	lb.	1.33	/ 2.45
Blacks and whites	lb.	1.43	/ 1.80
Colors	lb.	1.63	/ 2.05
Polyethylene:			
Alathons, Group I	lb.	.35	/ .43
Group II	lb.	.37	/ .515
Group III	lb.	.375	/ .42
Rulan 2	lb.	.48	/ .52
Styrenes:			
Lustrex Hi-Flows 55, 66, 77, & Hi-Heat 99, crystals	lb.	.275	/ .29
Colors	lb.	.315	/ 1.00
Pearls	lb.	.37	/ 1.055
Hi-Test 88, natural & black	lb.	.32	/ .34
Colors	lb.	.345	/ 1.00
LHA, natural	lb.	.31	/ .325
Colors	lb.	.34	/ 1.00
Utility black, gen. purpose	lb.	.205	
High impact	lb.	.26	
Medium impact	lb.	.215	

Domestic Production and Sales of Plastics and Resin Material, 1956 Totals and January, 1957

Following are the preliminary 1956 totals and the estimated January, 1957 statistics for domestic production and sale of plastics and resinous materials. Units listed are in pounds, dry weight, unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily restricted to the protective coating industry. Cellulosics showed a slight gain over 1955 figures, as did Urea-Melamines. Phenolics remained about the same, with Coumarone-Indenes losing some ground. Styrenes and the Miscellaneous category made noticeable gains; however, the really large increases are evident with Vinyls, Polyesters, and Polyethylenes. Over-all production figures were up almost 259-million pounds; sales about 271-million pounds.

	Preliminary Totals, 1956		January, 1957	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	19,383,669	19,626,935	1,440,428	1,309,744
Sheets, 0.003 gage and over	16,656,118	16,533,245	1,438,472	1,217,714
All other sheets, rods, and tubes	7,282,394	7,048,656	612,021	513,768
Molding and extrusion materials	92,744,685	91,721,018	7,455,973	7,000,531
Nitrocellulose sheets, rods, and tubes	5,254,287	4,834,837	376,988	488,843
Other cellulose plastics	5,651,149	5,158,877	524,756	307,946
TOTAL	146,972,302	144,923,568	11,848,638	10,838,546
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	214,728,646	190,456,640	17,558,707	16,674,519
Bonding and adhesive resins for—				
Laminating (except plywood)	62,832,035	44,365,011	5,211,501	4,139,273
Coated and bonded abrasives	15,644,206	16,505,780	1,692,440	1,670,029
Friction materials (brake linings, clutch facings, and similar materials)[7]	56,151,252	55,128,535	4,458,990	4,242,148
Thermal insulation (fiber glass, rock wool)	44,187,162	35,612,601	3,755,541	2,834,587
Plywood	49,788,936	47,636,880	4,913,746	4,415,928
All other bonding and adhesive uses	29,502,644	25,762,863	2,709,587	2,414,651
Protective-coating resins, unmodified and modified except by rosin	39,455,445	34,275,826	3,782,269	3,266,772
Resins for all other uses	512,290,326	449,744,136	44,082,781	39,657,907
TOTAL				
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	40,784,421	38,895,869	3,398,043	3,461,405
Paper-treating and Paper-coating resins	24,774,608	23,277,343	2,545,736	2,318,543
Bonding and adhesive resins for—				
Plywood	102,081,404	95,360,575	7,338,293	7,257,214
All other bonding and adhesive uses, including laminating	25,205,208	23,878,210	2,158,213	2,275,027
Protective-coating resins, straight and modified	37,249,525	27,816,969	3,488,263	2,630,538
Resins for all other uses, including molding	87,166,793	84,477,750	7,657,056	7,874,611
TOTAL	317,261,959	293,706,716	26,585,604	25,817,338
Styrene Resins:				
Molding materials[1]	433,036,877	389,384,474	32,295,697	36,093,284
Protective-coating resins, straight and modified	91,135,040	87,386,556	7,428,840	6,900,748
Resins for all other uses	104,415,845	104,973,111	11,211,112	9,874,756
TOTAL	628,587,762	581,744,141	50,935,649	52,868,788
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		78,064,204		8,094,174
Sheeting (resin content)		52,505,087		5,760,834
Molding and extrusion (resin content)		203,811,721		18,804,807
Textile and paper treating and coating (resin content)[3]		62,930,561		6,196,842
Flooring (resin content)		65,499,631		5,957,804
Protective coating (resin content)		28,521,587		3,076,650
All other uses (resin content)		74,621,127		3,438,158
All other vinyl resins for—				
Adhesives (resin content)		35,563,154		2,987,842
All other uses (resin content)		115,075,354		10,407,527
TOTAL	752,410,321	717,592,426	67,096,334	64,724,638
Coumarone-Indene and Petroleum Polymer Resins	245,585,916	241,845,584	17,643,660	18,431,928
Polyester Resins	72,587,769	65,291,568	7,264,772	6,443,851
Polyethylene Resins	556,919,133	509,398,977	52,356,773	53,187,799
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1,4]	43,541,644	40,712,576	4,654,617	4,541,687
Protective-coating resins[5]	11,448,208	5,723,057	1,170,018	483,276
Resins for all other uses[6]	117,894,300	109,311,942	10,174,445	10,312,804
TOTAL	172,884,152	155,747,575	15,999,080	15,337,767
GRAND TOTALS	3,405,499,640	3,159,994,691	293,813,291	287,308,562

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, nylon, silicone, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
[7]Included with "All other bonding and adhesive uses."
SOURCE: United States Tariff Commission, Chemical Division.

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May 20-24
National Industrial Development Exposition. New York Coliseum, New York, N. Y.

May 22
Reinforced Plastics Group, SPE New York Section. Tufaro's Restaurant, Corona, N. Y.

May 22-24
American Institute of Chemists. "The Chemist & Management Appraise Each Other." Thirty-fourth Annual Meeting. Sheraton-Mayflower Hotel, Akron, O.

June 5
SPE Western New England Section. Bradley Field, Windsor Locks, Conn.

June 6
SPE Southern California Section. Scully's Restaurant, Los Angeles, Calif.

June 10-20
British International Plastics Exhibition. Grand & National Halls. Olympia, London, England.

June 14
SPE Miami Valley Section. Annual Picnic. Elks Country Club, Hamilton, O.

June 16-21
ASTM Annual Meeting. Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

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